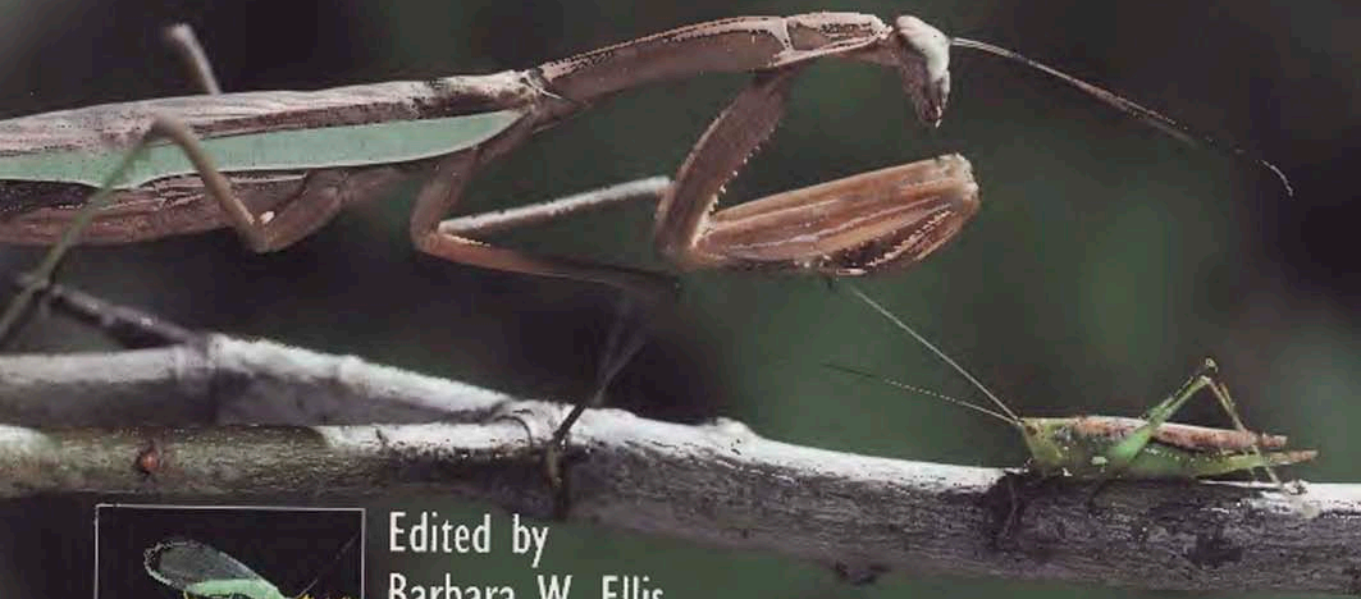
NEWLY REVISED WITH THE LATEST, SAFEST ORGANIC CONTROLS

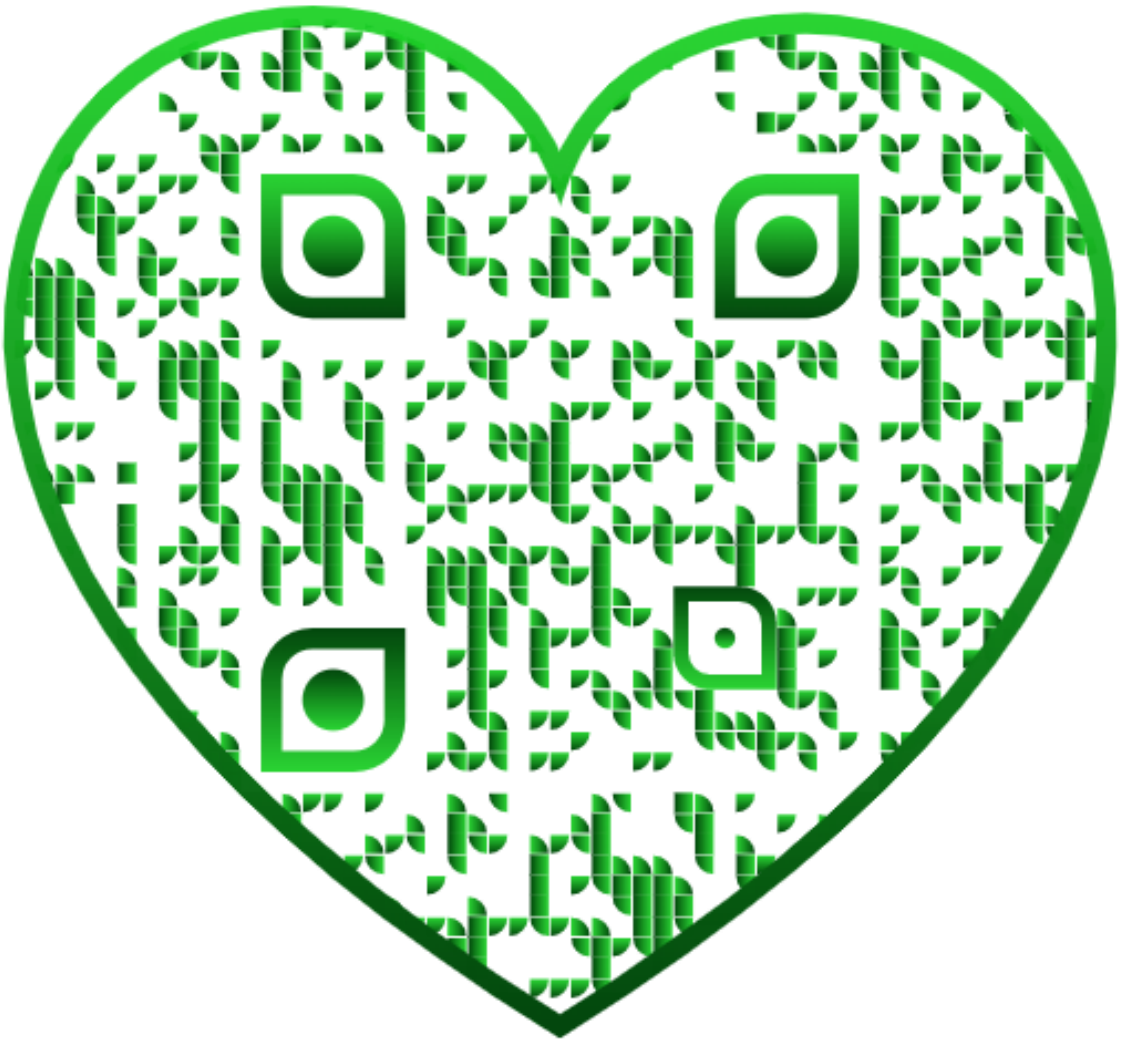
THE ORGANIC GARDENER'S HANDBOOK OF NATURAL INSECT AND DISEASE CONTROL

A New York Times BEST GARDENING BOOK

A Complete Problem-Solving Guide to Keeping Your Garden and Yard Healthy without Chemicals



Edited by
Barbara W. Ellis
and Fern Marshall Bradley



THE ORGANIC GARDENER'S HANDBOOK OF NATURAL INSECT AND DISEASE CONTROL

A Complete Problem-Solving Guide to Keeping Your Garden & Yard Healthy without Chemicals

EDITED BY

BARBARA W. ELLIS AND FERN MARSHALL BRADLEY

Contributing Writers: Helen Atthowe, Linda A. Gilkeson, Ph.D., L. Patricia Kite, Patricia S. Michalak, Barbara Pleasant, Lee Reich, Ph.D., Alfred F. Scheider

Rodale Press, Emmaus, Pennsylvania

The information in this book has been carefully researched, and all efforts have been made to ensure accuracy. Rodale Press, Inc., assumes no responsibility for any injuries suffered or damages or losses incurred during use of or as a result of following this information. It is important to study all directions carefully before taking any action based on the information and advice presented in this book. When using any commercial product, *always* read and follow label directions. Where trade names are used, no discrimination is intended and no endorsement by Rodale Press, Inc., is implied.

On the Back Cover (hardcover):
Left: Colorado potato beetle adult, larvae, and eggs. Photo by Ron West.
Right: Mealybug destroyer larva. Photo by Max E. Badgley.
Center: Convergent lady beetle attacking aphids. Photo by Ron West.

On the Back Cover (paperback):
Top: Colorado potato beetle adult, larvae, and eggs. Photo by Ron West.
Center: Mealybug destroyer larva. Photo by Max E. Badgley.
Bottom: Convergent lady beetle attacking aphids. Photo by Ron West.

If you have any questions or comments concerning this book, please write:
Rodale Press
Book Readers' Service
33 East Minor Street
Emmaus, PA 18098

Copyright © 1996 by Rodale Press, Inc.

All rights reserved. No part of this book may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any other information storage and retrieval system, without the written permission of the publisher.

Printed in the United States of America
on acid-free ♾, recycled ♻ paper

Senior Managing Editor: Margaret Lydic Balitas
Senior Editor: Barbara W. Ellis
Editor: Fern Marshall Bradley
Production Editor: Nancy J. Ondra
Contributing Editors: Nancy J. Ondra, Deborah L. Martin, Jean M. A. Nick, Paula Dreifus Bakule
Photo Editor: Heidi A. Stonehill
Copy Editor: Lisa D. Andruscavage
Editorial Production Coordinators: Stacy A. Brobst, Susan Nickol
Editorial/Administrative Assistant: Karen Earl-Braymer
Book Designer: Darlene Schneck
Cover Designer (paperback): Stan Green, Green Graphics
Front cover photo (hardcover): T. L. Gettings
Front cover photos (paperback): Dwight R. Kuhn
Illustrations: Julia S. Child, Jean Emmons

The Library of Congress has cataloged the original edition as follows:

The Organic gardener's handbook of natural insect and disease control : a complete problem-solving guide to keeping your garden & yard healthy without chemicals / edited by Barbara W. Ellis and Fern Marshall Bradley ; contributing writers, Helen Atthowe . . . [et al.].
p. cm.
Includes bibliographical references and index.
ISBN 0-87596-124-X hardcover
1. Garden pests—Control. 2. Organic gardening. 3. Plants, Protection of. I. Ellis, Barbara W. II. Bradley, Fern Marshall. III. Atthowe, Helen.
SB974.072 1992
635'.049—dc20 92-3372
CIP

ISBN 0-87596-753-1 paperback

Distributed in the book trade by St. Martin's Press

8 10 9 hardcover
10 paperback

CONTENTS

Contributors vii
How to Use This Book viii

PART 1 **Your Healthy Garden** x
A Plant-by-Plant Guide to Problem Solving and Prevention

Problem-Solving Plant Guide 11

PART 2 **Insects** 254
Recognizing Your Friends—Eliminating Your Foes

Insect Identification Guide 268

PART 3 **Diseases** 338
Identifying the Causes—Implementing the Cures

Disease Symptom Guide 370

PART 4 **Organic Controls** 404
Using Remedies Safely

Cultural Controls 410
Physical Controls 429
Biological Controls 447
Organic Sprays and Dusts 463

USDA Plant Hardiness Zone Map 486
Common and Botanical Names of Plants 487
Sources 489
Recommended Reading 493
Photography Credits 496
Index 499

CONTRIBUTORS

Writers

Helen Atthowe has a master's degree in horticulture (specializing in pomology) from Rutgers University. She has worked as a private pest management consultant and has worked with the New Jersey Cooperative Extension Service as an agent specializing in integrated pest management.

Linda A. Gilkeson, Ph.D., is coauthor of *Rodale's Chemical-Free Yard and Garden* and is an integrated pest management coordinator in the Ministry of Environment for the province of British Columbia. She has a doctorate in entomology from McGill University, Montreal, and has published several articles in scientific journals.

L. Patricia Kite is the author of *Controlling Lawn and Garden Insects, The Home Gardener's Problem Solver,* and *Organic Gardening: Vegetables* and coauthor of *California Cutting Garden.* A resident of Newark, California, she holds a master's degree in journalism and a teaching credential in biology.

Patricia S. Michalak has a master's degree in entomology from Michigan State University. She applies her ten years of research experience in agricultural entomology to her efforts as a freelance writer. She markets herbs and gourmet vegetables organically grown at her farm, Long and Winding Row Farm, in Kempton, Pennsylvania.

Barbara Pleasant is the author of *The Handbook of Southern Vegetable Gardening* and is a contributing editor for *Organic Gardening* magazine.

Lee Reich, Ph.D., is the author of *Uncommon Fruits Worthy of Attention* and *A Northeast Gardener's Year* and a former fruit researcher for Cornell University and the U.S. Department of Agriculture. He currently is a horticultural consultant and writer.

Alfred F. Scheider holds a bachelor's degree from the New York State College of Agriculture at Cornell. He is the author of *Success with Bulbs* and has had articles published in the *New York Times, House Beautiful,* and *House and Garden.*

Editors

Barbara W. Ellis has a bachelor of arts degree from Kenyon College in Ohio and a bachelor's degree in horticulture from The Ohio State University. She is a former publications director/editor for *American Horticulturist,* the publication of the American Horticultural Society, and is the senior editor of garden books at Rodale Press.

Fern Marshall Bradley has a bachelor's degree in plant science from Cornell University and a master's degree in horticulture from Rutgers University. She has managed an organic market garden and is a garden book editor at Rodale Press.

HOW TO USE THIS BOOK

Whether it's spots on the tomatoes, melons that wilt and die mysteriously, or worm-eaten apples, damage from insects and disease organisms is never welcome. How to manage these problems is a top concern of gardeners everywhere. This book is specifically designed to help. Its quick-reference format quickly leads you to complete control information for a wide range of common insect and disease pests.

How to Find It

One look at the contents will illustrate that *The Organic Gardener's Handbook of Natural Insect and Disease Control* is really four books in one. Once you've paged through it to familiarize yourself with the format, flipping to the section you need will become second nature. And for quick and easy access to information, don't forget the index. Here's a rundown of what is included in the pages that follow.

Part 1, Your Healthy Garden: A Plant-by-Plant Guide to Problem Solving and Prevention, contains a plant encyclopedia with symptoms and solutions for major problems of popular plants, including fruits, vegetables, annuals, bulbs, perennials, and trees and shrubs. It also contains preventive information and general entries on major plant groups—plus stunning illustrations of common problems on the most popular garden plants.

Part 2, Insects: Recognizing Your Friends—Eliminating Your Foes, contains information on managing pest insects and attracting beneficials. It also features a photographic "Insect Identification Guide" of more than 100 common pests as well as more than 20 types of beneficial insects. (The names of the beneficial insects are set in green type; the names of the pest insects are in black.)

Part 3, Diseases: Identifying the Causes—Implementing the Cures, is a primer on plant disease that will help you diagnose and control problems caused by fungi, bacteria, and viruses. In this part, you'll also find a photographic "Disease Symptom Guide" to help you identify problems in your own garden.

Part 4, Organic Controls: Using Remedies Safely, is an encyclopedia of organically acceptable control techniques and products. The major types of controls (cultural, physical, biological, and organic sprays and dusts) are presented in order of least to most invasive to make it easy to choose the best control.

Remembering the Big Picture

As you use this book, though, it's important that you not lose sight of the big picture of gardening organically. One of the principles that is at the heart of organic gardening is eliminating the need to use sprays and dusts at all—even organically acceptable ones. This may seem impossible at first, even foolhardy, but organic gardeners everywhere will attest to the fact that it makes gardening more enjoyable—and safer—than ever.

So where do you start? Logically enough, at the beginning. The opening pages of part 1 of this book give you the big picture of organic garden management. If you skip right to the controls listed in the plant encyclopedia entries or to the control sections in parts 2 and 3, you'll be missing loads of valuable informa-

tion that can help prevent pests from reaching a problematic level in your yard and garden.

Surprisingly, most of the best ways to control pests and diseases may not seem like controls at all. Organic gardeners look at their gardens as an overall system that should be kept in balance, so no one pest or disease gets out of hand. They concentrate their efforts on cultural techniques that prevent problems, such as keeping their plants in top-notch health and cultivating rich, organically active soil. They also try to encourage a diverse community of predators to keep pests in check.

While the individual plant, insect, and disease entries do list some preventive measures, they are primarily designed to help you decide what to do once you've encountered specific problems in your garden. But keep in mind that preventive measures are the keys to successful organic gardening. To get the most out of this book—and to develop an effective pest- and disease-control system for your garden—take the time to review the preventive methods discussed in the introduction to part 1, and follow up by studying the descriptions of these methods in part 4. Then, make a plan to begin implementing them in your garden.

Of course, you'll also find that this book is an invaluable reference for finding solutions to garden problems: Throughout these pages, you'll find up-to-date, detailed information on how to handle problems. When you do refer to recommendations for controlling a specific insect or disease, always use the least-invasive method available. Cultural controls are generally the most benign, followed by physical and biological controls. Organic sprays and dusts should always be considered a last resort.

Since botanical pesticides are organically acceptable, we include them in our recommendations throughout this book. So there are hundreds of recommendations for applying botanical chemicals as well as sulfur and copper fungicides. This does not mean we are endorsing widespread use of botanical pesticides. It will only be in *exceptional* cases in any individual home garden that the chemical method will be needed. It's critical to remember not to rely on a control approach—you'll be most successful, and safest, if you emphasize practices to promote garden health, and use this book for problem solving in those few cases when a pest population gets out of balance.

If you do decide to use one of the botanical sprays or dusts, *always* remember that they can be dangerous, especially to the person applying them. There is a reason these products kill insects! Never use them casually or carelessly. And whenever you use commercial products, *always* read and follow label directions.

PART 1

YOUR HEALTHY GARDEN

A Plant-by-Plant Guide to Problem Solving and Prevention

Controlling pests and diseases organically means much more than simply changing the types of sprays and dusts you use. Organic gardeners strive to develop a balanced system where problems are regulated naturally and where there is little need to use even the safest organic sprays and dusts to control pest problems.

Throughout this book, you'll find hundreds of nonchemical suggestions for stopping insects in their tracks or curbing diseases before they overtake your yard. There are also recommendations for using organically acceptable fungicides and insecticides. These are offered as a last resort—for the exceptional cases when the natural balance has been disturbed and pest problems threaten to ruin the harvest or kill your plants.

To understand why maintaining the natural balance in your garden is important, it helps to think about wild systems like a woodland or meadow. Have you ever wondered why pests and diseases haven't overrun the plants growing there? The answer is that over time, the community has developed a system of checks and balances that prevents devastating outbreaks of pests or diseases. Some insects in a woodland or meadow eat plants, but natural predators and parasites keep their numbers in check. The cycle of plant growth and decay ensures that soil fertility will be maintained to help keep plants healthy and more resistant to insect and disease problems. Plants that can't adapt to the prevailing climate and soil conditions will lose out, and a plant mix that can thrive in those conditions will survive. This natural system is at work in your own garden, and this book is about the many ways you can make these natural checks and balances work for you.

As you peruse the entries in the "Problem-Solving Plant Guide" beginning on page 11—as well as the sections on insects, diseases, and controls that follow—notice that many of the recommendations for controlling pests and diseases don't involve sprays or dusts at all. You'll find suggestions for proper site selection and preferred soil conditions, tips for avoiding or preventing conditions that promote pest and disease outbreaks, and recommendations for steps you can take to prevent problems *before* they occur. That's because keeping plants healthy and preventing problems by proper plant selection and culture are two fundamental principles of gardening organically.

Plan for Healthy Plants

Every minute of every day, the plants in your yard are defending themselves from their natural enemies. When a gust of wind breaks a branch from a tree, chemicals concentrated at the base of that branch mobilize into a protective wall to prevent pests from invading the healthy parts of the tree. When insects nibble on the leaves of a shrub, the plant may respond by changing its leaf chemistry to make itself less appetizing. As earthworms break off pieces of grass roots in their endless tunneling, the grass may turn injury into opportunity by growing two new roots where there used to be one.

Happy Equals Healthy

Maximizing natural resistance is one important way good gardeners keep their gardens flourishing. Pests and disease organisms prefer plants that are weak, injured, or unable to adjust to the site on which they have been planted. For example, when planted in a hot, sunny site, rhododendrons and azaleas are more prone to attack by lace bugs, which aren't a major problem in shady sites. On the

other hand, when grown in a suitable climate and provided with healthy soil and an appropriate site, plants generally thrive and are highly resistant to problems. Most plants will have trouble-free lives if provided with growing conditions that closely match their natural preferences. There generally isn't much more the gardener needs to do to keep them happy and healthy. Plants forced to live in conditions that don't suit their needs—with the wrong soil moisture level and sunlight exposure, for example—are doomed from the start. Much of the intrigue of gardening involves discovering—or creating—the perfect growing situation for a special plant.

As you develop your garden, take time to study each site before you decide what to plant there. Then select plants that will thrive in the conditions available. If you match the plant to the site, you're well on the way to a successful garden.

Bear in mind that some pests and diseases can be prevented by site selection alone. For example, a site on which morning sun quickly dries leaves dampened by dew will help limit the conditions many molds and mildews need to flourish. Site selection also can help limit insect-transmitted diseases. When beets are grown close to tomatoes, beet leafhoppers can easily carry a virus called curly top to tomatoes. Flea beetles normally cause only cosmetic damage to potatoes (tiny holes in the leaves), but can move on to corn and infect that crop with bacterial wilt. Whenever you learn that a pest common in your area serves as a vector for disease, separate host plants as much as possible, both physically and by crop timing, to help interrupt the pattern of disease transmission.

Handle with Care

One of the best ways to keep plants healthy and happy is to treat them with care. Bruised or torn leaves, damaged stems, and other plant wounds not only cause unnecessary stress that can weaken plants, they're an open invitation to pests and disease organisms, which find it easy to enter plants through damaged tissue. Keep this in mind whenever you're in your garden, and avoid handling plants whenever possible. Whenever you do need to work in your garden—even walk down the rows between plants—touch the plants gently to keep damage to a minimum. *Never* work around plants when they're wet. Many disease organisms (and some pests, too) travel easily on the film of water that covers foliage on damp days. When you work among wet plants, you're likely not only to help spread disease organisms, but also provide them with easy access to your plants via bruised leaves. Tugging on plants when you harvest fruit or pick flowers can damage roots and stems: Always use a sharp knife or pruning shears to make a clean cut that will heal easily. The same goes for proper pruning.

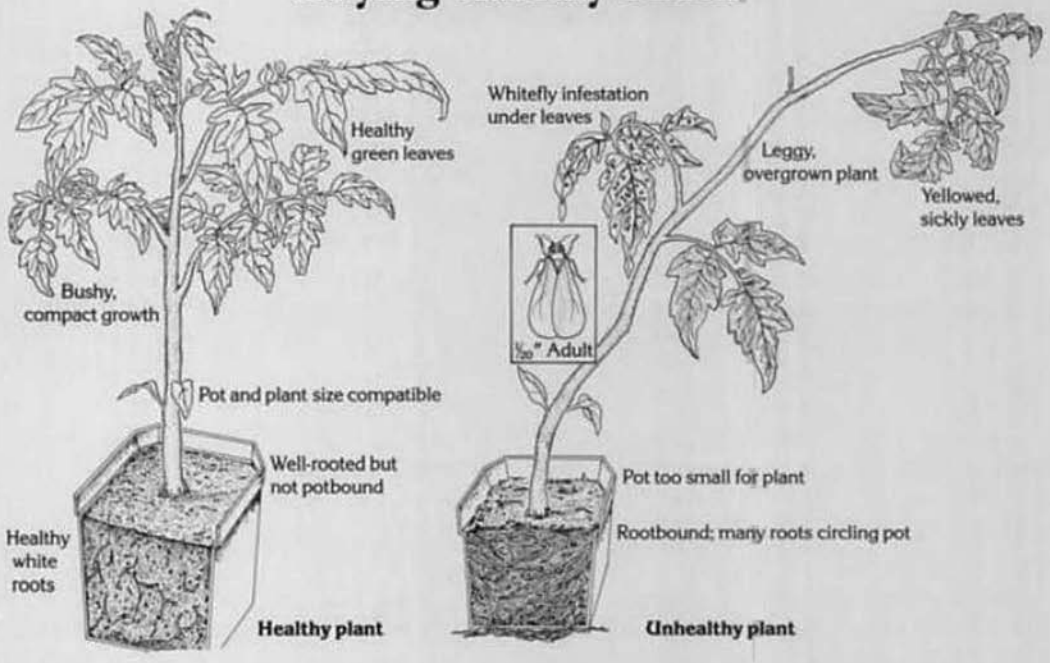
Handling trees with care is one of the best ways to keep them healthy. Many tree pests can only invade through the exposed tissue at an injury site. For example, flowering dogwood is normally a very insect-resistant tree, its trunk protected by a thick, hard bark. But when bits of bark are broken away, as when you hit a young dogwood with a lawn mower or string trimmer, that injury becomes a point of entry for dogwood borer larvae—a very difficult-to-control pest that eats its way through living wood.

Cultivate Healthy Soil

Cultivating healthy soil is at the foundation of growing healthy plants. Good soil helps plants nurture themselves. Roots flourish in healthy soil. They're able to find and use nutrients as needed, which helps the plant grow strong and resilient.

When grown in poor, compacted soil that is low in nutrients, plants will grow weakly and be stressed by nutrient deficiencies. As a result, they'll be easy prey for insects and

Buying Healthy Plants



Starting out with the healthiest plants available is a great way to ensure a healthy garden. Use these tips to pick the best plants you can find.

- Look for a sales display where the plants are well cared for. Plants subjected to hot, sunny sidewalks, allowed to wilt frequently, and watered unevenly are never a bargain, no matter how cheap.
- Look at the entire group of plants being offered for sale. If some of the plants seem to be in poor health, shop somewhere else. Those that look healthy today may be diseased tomorrow.
- Shop early in the season, when selection is good and plants are young.
- Examine the roots. Gently shake a plant out of its container. Roots should be plentiful, but not wrapped into a tight spiral. With bare-root plants, look for fungi, lesions, and broken tissue; prune them off before planting.
- Consider plant color. Pale overall color indicates a need for nutrients, which is easy to correct. However, distinct yellow streaks or brown leaf spots indicate presence of disease.
- Buy perennials, trees, and deciduous shrubs when they are dormant or just beginning to bud out. Leaf emergence above ground is accompanied by rapid root growth below. Get plants situated before this growth spurt occurs.
- If bedding plants are already in flower, pinch off the blossoms when you set them out. Pinching will help direct the plant's energy into growing roots, so it will be better able to support more flowers and fruit later in the season.

diseases. In contrast, soil that is fertile, well-drained, and teeming with communities of diverse microbes sharply increases a plant's chance at a healthy, productive life. Also, since many pest and disease organisms spend part or all of their lives below-ground, having a diverse community of organisms to keep them in check is important.

Healthy soil is an intricate mix of tiny rock particles, organic matter, water, air, microorganisms, and other animals. Living things abound in a robust, organically active soil—plant roots, animals, insects, bacteria, fungi, and other organisms. The more organic matter you provide, the livelier the life forms within your soil are likely to be. And, the livelier the soil life becomes, the more heated competition becomes between beneficial and benign soil microorganisms and those capable of doing harm.

Over time, adding organic matter improves soil structure, which in turn improves the soil's ability to absorb and release water. Obviously, without water plants cannot thrive, but too much water can also sabotage plant health. When soil becomes saturated, and water pools up around plant roots, the roots may lose their ability to take up nutrients. Tiny root hairs may begin rotting away, followed by entire root branches. As organisms that cause root rot flourish, the plant may weaken. Above-ground, the plant may be simultaneously attacked by molds and mildews encouraged by damp conditions. In this way, plants can easily die from too much water.

There is tremendous variation in how much water plants can use, and here, too, the question of natural resistance comes into play. Plants that are naturally adapted to wet conditions are resistant to many of the pathogens present in chronically wet soil; those that grow naturally in dry or very well drained settings are easy prey to those same pathogens.

Local soil conditions have an important bearing on what plants are best for your garden. Soil pH affects the availability of certain nutrients to a plant, affecting its overall vigor, thus directly affecting its ability to maintain good health. Where soil tends to be very acidic, plants that like a low pH, such as blueberries and rhododendrons, will be much happier than plants such as asparagus and clematis, which require close monitoring and frequent applications of lime when grown in very acidic soil. Although soil pH is easy to manipulate using organic matter, mineral fertilizers, and mulches, it's wise to consider the natural pH of your soil when choosing long-lived plants.

To help ensure that your soil is healthy and balanced, take the time to learn about its characteristics and fertility levels. It's a good idea to have it tested by the Cooperative Extension Service or by a private laboratory. Use the results as a guide to bring your soil into balance by adding lime, compost, or organic soil amendments and fertilizers as needed. Maintain soil balance by growing green manure crops and adding organic matter each season.

Select Trouble-Free Plants

Some plants are naturally prone to diseases; others are like sparkling beacons to hungry insects. You can eliminate many problems in your garden by avoiding pest- or disease-prone plants. Instead, fill your property with dependable plants that can fend for themselves. In any climate, there are hundreds to choose from. With a solid collection of easy-to-grow plants in place, you can limit your pest-control activities to plants you consider indispensable. Tomatoes are prone to pest problems, but most gardeners agree that vine-ripened tomatoes are well worth the time and trouble they must take to select the best-adapted cultivars, create ideal soil conditions, and patrol the tomato plot regularly to stay on top of insect and disease activity.

Plants differ in their ability to defend

themselves from pests and diseases, and choosing resistant species and cultivars is another basic strategy for limiting pest problems. For example, instead of growing disease-prone hybrid tea roses, you can select from among the new, easier-to-satisfy cultivars of shrub roses, which require little care beyond occasional pruning. In addition to the discussion of plant resistance on page 412, you'll find many suggestions for disease- and insect-resistant cultivars throughout the "Problem-Solving Plant Guide" beginning on page 11. Planting them is often the best way to eliminate a problem altogether. Remember, though, even with resistant plants, proper site selection and preparation are essential.

Feed Regularly

Although rich, well-fed soil is all many plants need to keep them growing vigorously, fertilizing them at the proper time is also beneficial and will help enhance their natural resistance to pests.

As a general rule, make sure annual vegetable and flower crops are well-fed when they are young, and then give them a modest booster feeding when flowering and reproduction commences. Fertilize perennial vegetable and flower crops, along with trees and shrubs, during the first third of their active growth, which is just as they begin growing in spring. You can also fertilize during the second third of the plants' growing season, but not during the last third. Late fertilization can stress the plants by encouraging tender new growth that may be winterkilled. When you apply fertilizer, always keep in mind that more isn't necessarily better. Overfertilizing leads to rank, spindly growth and can even worsen problems with aphids and some other pests.

Encourage Diversity

Any yard or garden is home to countless forms of microscopic life and hundreds of different kinds of insects as well as birds, toads, frogs, mammals, and humans. Relationships within this community are mind-boggling in their complexity, but encouraging a diverse community is a valuable way to ensure a healthy, trouble-free garden.

Rotate Crops

Crop rotation is one way diversity helps prevent problems in your garden. Consider what happens in a monoculture, such as a field planted year after year with corn. In the first year, some corn pests, such as European corn borers and corn earworms, will find the field, eat their fill, and leave eggs or overwintering pupae in the debris that remains after harvest. The following spring, the new generation of pests can get right to work feeding and reproducing themselves. The same is true for disease organisms that develop in the field. Favored host plants are easy to find and are available every year. As a consequence, pest populations can build out of all proportion.

Rotating (essentially taking away) a pest's or disease's preferred host plant hampers its ability to feed and reproduce. If the cornfield were planted with wheat the following year, the borers and earworms would be forced to look someplace else for food. They could not continue to feed and build their populations on that site. Another example of crops that benefit from rotation is members of the cabbage family (Cruciferae). Many diseases such as black leg (a fungus) and black rot (a bacterium) can quickly establish themselves in a cabbage patch. The first year's crop may get by with minimal damage, but if cabbage, broccoli, cauliflower, or other crucifers are planted there again the following year, the disease organisms are ready and waiting to infect defenseless young plants. Rotating cabbage family members with crops that belong to other plant families breaks the disease cycle. For more on crop rotation, see page 415.

Fortunately, rotation generally isn't nec-

essary for long-lived plants such as trees and shrubs, because they have developed their own pest-control strategies that enable them to live long, trouble-free lives. (Unless, of course, you lose a tree to a soilborne diseases such as Verticillium wilt, in which case you shouldn't replace it with another susceptible species.) Below ground, trees and shrubs may release chemicals into the soil that act as natural pesticides to soilborne fungi and bacteria. Above ground, their tough, woody stems help resist bruising and insect attacks. When leaves are lost to disease, a shrub or tree has the ability to produce new leaves several times. When leaf-eating insects dine on tree leaves, the tree may respond by pumping more tannic acid into the leaves that remain, thus deterring further feeding.

Avoid Monocultures

Planting a wide variety of plants is another way to foil pests and diseases by encouraging diversity. Conventional lawns, a type of monoculture, are a good example. Planting a mixture of lawn grasses (especially disease-resistant ones) will help prevent diseases from sweeping through your lawn, because some plants will be susceptible and others won't. Replacing some of your lawn areas with a variety of tough groundcovers will also increase the overall diversity of the home landscape. It's an excellent alternative for sites on which lawn grasses won't naturally thrive.

The importance of using diversity is especially apparent if you look at long-lived plants such as trees and shrubs. Using a large planting of a single species of tree or shrub to screen a busy roadway, or planting the same shade tree that all your neighbors have, are two more examples of monocultures. A devastating pest or disease that appears on the scene can easily move from plant to plant and damage or wipe out the entire planting in a single season. Dutch elm disease, which decimated American elm plantings along thousands of American streets in the mid-1900s, is a perfect example of the dangers of mass planting single species. If you've planted a variety of trees and shrubs for screening or shade, you have built-in protection.

Companion planting is another way to use diversity—and avoid monocultures—to foil pests. Mixing marigolds or strong-smelling herbs in the vegetable garden, as opposed to planting solid blocks or rows of a single crop, is effective, because many pests locate crops by smell. Interplanting can "hide" a crop by masking the odor that attracts pests. Some companion plants work by repelling pests. For example, basil is said to repel tomato hornworms. For more on the many ways companion planting can be used to control pests and diseases, see page 419.

Encourage Natural Predators

Encouraging a diverse community of insect predators is another way organic gardeners manage pests. *Beneficials,* the term usually used for insect-predatory and parasitic insects and arachnids, such as spiders and mites, play a vital role in the complex community that naturally exists in your yard. Many actively help plants reproduce by spreading pollen; others consume or parasitize destructive pests. Beneficials such as lady beetles and honeybees are well-known. Other effective beneficials include lacewings and assassin bugs. For more on beneficials, see pages 258 and 453.

Birds are among the most efficient insect predators. When you consider that chickadees spend much of their time during the winter eating aphid eggs or that Baltimore orioles can eat up to 17 tent caterpillars a minute, you won't wonder why many gardeners want to attract birds to their yards. Planting trees and shrubs that provide food and shelter, along with providing a source of fresh water year-round, will go a long way toward encouraging birds to visit your yard.

And for consuming slugs, cutworms, and

other ground-dwelling pests, nothing beats a resident toad! Be sure to provide shelter and water for these hard-working garden residents.

Develop a System

Keeping plants thriving, improving your soil, planting a variety of plants, and encouraging natural predators are all great ways to prevent pest and disease problems, but planning and record keeping are also essential weapons to add to your arsenal. A garden plan will help you develop a calendar of activities aimed at preventing problems. It will also help you set and achieve goals for your garden, such as eliminating or modifying problem-prone plantings or adding new gardens. Regular record keeping will help you know when to expect problems so you can get a head start on them.

Start your plan by finding out about the plants you're growing as well as the ones you want to grow. Learn what conditions they prefer and which will grow best in your area. Next, draw a sketch of your garden. Mark down existing plantings, but also look for sites that might suit some plants but discourage others. For example, locate frost pockets, sites where air will circulate freely, areas with moist soil, and shady or sunny spots.

Then identify and list the problems you've had in the past or that are common in your area. Use the "Problem-Solving Plant Guide" on the pages that follow to identify problems you've seen in your garden before. Learn about the life cycles of these pests and diseases. How do they overwinter? When and how do they attack your plants?

Once you have all your options—and potential problems—in front of you, make a comprehensive plan. Next, list the ways you could help control each of the problems on your list. Decide what cultural controls will help prevent problems and when they need to be done. Add the biological and physical controls next, and make note of organic sprays and dusts for use as a last resort. Be sure to include the life cycle stage at which each control is most effective. It may help to make a chart of the life cycle and control activities.

Use these notes to create a schedule of gardening activities. You'll find that certain chores, such as an annual fall cleanup, are well worth the effort because they'll prevent many types of pests. Planning ahead and following your schedule will enable you to make full use of preventive control measures, and they'll soon become second nature to you. You'll also know what tools and materials to have on hand to fight problems if they arise.

Learn to Look

All the planning in the world won't help if you don't keep an eye out for problems. Begin a garden journal for keeping records throughout the season. Make it a habit to walk through your garden at least once a week—daily is best. Look carefully at your plants, turning over leaves, and note overall appearance.

In your garden records, include pest appearance dates and details of insect behavior along with notes you make on the progress of various plants. This is the only way to discover useful facts, such as when birds are no longer effective cabbageworm predators on cabbage, cauliflower, or broccoli, or which members of the huge daisy family are first to be attacked by four-lined plant bugs.

If you notice plants that don't look healthy or aren't growing the way you'd expected, take time to examine them more closely. Look for signs of the problems you listed, and go over your plan to see what steps you need to take. Use the "Pest Patrol Checklist" on the opposite page to gather the information you need to diagnose the problem. Once you've diagnosed the problem and identified the ways to control it, add the necessary information to your garden plan.

Keep notes on your program during the

Pest Patrol Checklist

In general, plant problems are divided into three main types: pests (including insects, mites, nematodes, even gophers and mice), diseases (such as bacteria, viruses, and fungi), and physiological problems (like nutrient and water imbalances, too much or too little light, or extreme temperatures). These conditions can interact, or one condition might predispose the plants to another. For example, root maggots tunneling in roots directly damage them, but the reason the plants may subsequently die is because rot organisms invade the damaged areas and then spread through the entire root system.

Diagnosing a pest problem on a plant is easiest if you catch the culprit in the act; then it's just a matter of identifying the pest. But reaching a diagnosis often takes patience and careful observation, because the insect that caused the damage may only feed at night or underground. In addition, insect damage often resembles infections from fungi or viruses, nutrient deficiencies might look like a viral disease or vice versa. In these cases use the steps below to collect as much information as you can. Then use the plant, insect, and disease encyclopedia sections of this book to determine the cause of the problem.

1. Examine the entire afflicted plant and note the range of abnormal symptoms. Is the entire plant affected or just a part of it? If a part is affected, what part? Do you see symptoms only on the new growth or old growth, or on a single branch? Is just one plant affected, or do you see symptoms along an entire row? If plants are affected randomly within a row or bed, and the symptoms do not spread to the other plants, the problem is probably not an infectious disease. Clusters of plants showing symptoms may indicate disease, or just a pocket of poor soil.

2. Examine both the affected areas and healthy portions of the plant with a magnifying glass. Inspect the leaves, especially on the undersides, stems, flowers, and roots, if possible. Look for signs of hidden damage, such as borer holes in stems or fine webbing on the undersides of leaves. To avoid damaging roots when you observe them, dig the plants rather than pulling them from the ground. Carefully wash soil off the roots for easier inspection.

3. Check the condition of the soil. Is it poorly aerated, encouraging root rots or at least poor root function? Or is the soil droughty, so plants wilt from lack of water? If soil conditions are poor, root systems may not be able to spread in search of nutrients, and plants in that area may suffer from nutrient deficiencies.

4. Collect any insects associated with the ailing plant, or take samples of damaged leaves. Seal samples in pill bottles or clear plastic bags.

5. Use the information you've gathered to narrow down the possible causes, using the information and photographs in this book. You may also want to refer to other insect, disease, and horticulture handbooks for help in confirming your diagnosis and identifying species and for advice on how to deal with the problem.

6. If you are still stumped, review everything you know about the conditions preferred by the plant, correct any environmental or nutritional deficiencies, and give the plants the best care you can. Many unexplained afflictions are physiological in origin and plants often grow out of them when conditions improve. Bear in mind that nutrient problems will take weeks or even months to correct. If more plants in the row become affected, as might happen if disease is spreading, pull and discard the damaged plants to reduce the source of disease.

Cultural Questions

Use the following questions to help organize your thinking about the causes for garden problems and the possible ways you could prevent them by improving plant culture.

- Is the plant growing in an appropriate soil type with the kind of exposure and drainage it requires? Is the pH within tolerable limits? Should you move the plant? If so, when is the best time?
- Are climatic factors limiting the plant's growth? Could windbreaks, winter protection, early planting, or use of a different species solve the problem?
- Have you given the plant too little or too much fertilizer? Have you fertilized it at the appropriate times?
- How severe is the damage? Is it cosmetic or is the plant's health really deteriorating? If you have seen this pest before, did the affected plants outgrow the problem?
- Is the pest soilborne and/or indigenous and likely to appear year after year?
- Have you followed appropriate crop rotations?
- Is the plant surrounded by good companions or bad ones?
- Can you remove affected plant parts to stop the progress of the pest?
- For insect pests: Does the pest fly, jump, or remain stationary? Are other plants likely to become infested? Are natural predators present?
- Is the plant too old to adequately defend itself? Could healthy replacement plants solve the problem?
- Could you replace the plant with one that is resistant to the problem?
- Have you chosen the control with the most limited environmental impact?
- Are there routine garden tasks you could use, such as annually raking and removing afflicted leaves, to control the problem?
- Have you made plans for nurturing follow-up care to help the plant recover from the pest challenge?

season. Write down what works and what doesn't, what controls you used, how much you used, and where. The more information you have, the better you'll be able to refine the plan for the next season.

The more time you spend in your garden, the better you will be able to recognize, understand, and treat pest problems. When you consider pest problems thoughtfully, you may be surprised at how little damage actually has occurred. Many plants can tolerate up to 30 percent loss of foliage without suffering serious cuts in productivity. And, although leaves with little holes in them don't look nice, they may actually help the plant defend itself by triggering the production of pest-repelling chemicals.

You'll also gain a greater appreciation for just how well plants can keep themselves healthy, given the opportunity. Even in the middle of summer, when pest problems are most severe, bear in mind that the crisis will pass and your plants will get another chance with each new season. Plants have been making use of these second chances, devising their own self-defense tricks and strategies, since time began. Learning and using natural pest-control maneuvers gets you involved in these adventures, which are part of the fun and fascination of gardening.

PROBLEM-SOLVING PLANT GUIDE

Use this encyclopedia of over 200 popular garden plants to help diagnose, prevent, and control problems throughout your garden. Individual plant entries include symptoms for the most common garden problems you may encounter, suggestions for cultural measures that help prevent problems, and control options for specific pest and disease problems.

Food plants—vegetables, fruits, and herbs—are listed by common name. However, ornamentals—annuals, bulbs, perennials, and trees, shrubs, and vines—are listed by botanical name. If you don't know the botanical name of a particular plant, there are two quick ways to look it up. For example, suppose you want information on disease problems of lilacs, and can't find a Lilac entry. One option is to look up lilac in the index. It will refer you to the *Syringa* index entry, where you'll find page listings. Or, you can turn to "Common and Botanical Names of Plants" on page 487, look up lilac, find the botanical name *Syringa,* and then go to the Syringa entry in this section of the book.

The entries are designed to help you quickly zero in on specific plant problems. In the "Problems" section of each entry, you'll find short descriptions of symptoms in boldface type, such as **"Leaves with yellow, V-shaped spots on margins."** Scan these descriptions until you find the one that most closely matches the problem on your plant. You can then read that section in the entry to learn the cause of the problem and how to avoid or control it.

In addition to the individual plant entries, you'll also find separate general entries on annuals, bulbs, herbs, lawns, perennials, and vegetables, along with an entry on trees, shrubs, and vines. These general entries highlight problems that attack a wide variety of plants. You'll find them useful for solving some of the most common problems that attack your garden.

If you're using this guide to diagnose a specific plant problem, always be sure your diagnosis is correct before deciding on a control strategy. If you want more help in identifying a specific problem, you'll find photographs and descriptions of specific insects and diseases in the "Insect Identification Guide" beginning on page 268 and in the "Disease Symptom Guide" beginning on page 370.

For more detailed information on how to safely and effectively use specific controls, refer to "Organic Controls" beginning on page 404. Controls are divided into four categories: cultural, physical, biological, and organically acceptable chemical controls. If you're not sure which category a particular control belongs to, your best bet is to look it up in the index.

Descriptions of the controls include information on the protection they offer, toxicity to nonpest organisms, and any possible hazards related to their use. When choosing a control strategy, always start with the lowest-impact control possible, and only use chemical controls as a last resort.

Abies

Fir. Trees.

Firs are cone-bearing evergreens with needlelike foliage and a symmetrical form, especially when young. They make impressive specimens or, in groups, effective dark backgrounds and tall screens.

Firs grow best under cool, moist conditions; they do not thrive in hot, dry climates. Set container-grown or balled-and-burlapped plants into acid, moist but well-drained soil, preferably in spring. Full sun is best, but firs will grow well (with a somewhat more open habit) in partial shade. Fir trees are seldom bothered by insects or diseases in the landscape. Planting healthy trees in the right conditions will help the plants avoid most potential pest problems.

Problems

Needles deformed. Cause: Balsam twig aphids. This 1/8" long, greenish aphid has a white waxy coating. It feeds primarily on succulent new growth and exudes sticky honeydew, which covers the needles. Most of the damage occurs in late spring to early summer. Control with insecticidal soap, or spray with pyrethrin for severe infestations.

Needles light gray or bronze. Cause: Spruce spider mites. These tiny, spiderlike pests damage needles as they feed; the injury weakens the plant and can kill young trees. Mites start feeding on lower, older needles and progress upward and outward; tiny webs may be visible on needles. Control in spring with dormant oil before growth starts. During active growth, spray plants repeatedly with strong jets of water or make 2 applications of insecticidal soap 7-10 days apart; apply pyrethrin for severe infestations.

Branches defoliated. Cause: Hemlock loopers. The 1" long, greenish yellow, black-spotted caterpillars usually appear in June. They feed on the needles, starting from the branch tips and working toward the center of the plant. Handpick small populations; control large infestations with BTK.

Branches with brown tips. Cause: Spruce budworms. These brown, 1" caterpillars have white dots on their backs. They start tunneling into older needles and gradually migrate to opening buds. Damaged needles turn brown and drop; you may see tiny webs on shoot tips. Prune off affected branch tips or handpick if only a few pests are present. Spray severe infestations with BTK.

Plant defoliated; branches bear cocoonlike bags. Cause: Bagworms. See "Plant defoliated; branches bear cocoonlike bags" on page 236.

Acer

Maple. Trees.

Maples are a large group of easy-to-grow, 15′-100′ trees with opposite leaves and distinctive, 2-winged fruit. They are popular as street or specimen trees.

In general, maples prefer rich, moist but well-drained, acidic soil and a sunny position. Some smaller species, such as Japanese maples (*Acer palmatum*), need at least partial shade. Set out maples in spring as container-grown or balled-and-burlapped plants.

Although they can host a range of pests, most maples survive nicely with little or no spraying. Note that oil sprays and insecticidal soaps may damage some maples; before using either product, note restrictions on the label and use with caution. Test on a few leaves before treating the whole plant.

Problems

Leaves with brown, dry edges. Cause: Leaf scorch. Caused by lack of water or reflected heat from surrounding pavement, this damage is often a problem on newly planted trees. Avoid by keeping soil around the tree evenly moist; a 2″-3″ thick layer of mulch keeps roots cool and retains moisture.

Leaves yellow; whole plant weakened. Cause: Maple scales. Both maple phenacoccus and cottony maple scale produce small, fluffy, white egg masses. They feed on leaves and stems, weakening the plant. Spray the trunk and branches with dormant oil before growth starts in spring, or with superior oil or insecticidal soap as buds begin to open. Repeat the soap or superior oil application in midsummer, spraying the leaves and branches.

Leaves and shoots blackened; leaves with moist or brown sunken spots. Cause: Anthracnose. See "Leaves and shoots blackened; leaves with moist or brown sunken spots" on page 238 for more details on this disease.

Leaves distorted or bumpy. Cause: Mites. Several different mites attack maple leaves, causing pointed or wartlike swellings in various colors. Although they are unsightly, galls don't seriously threaten tree health. Pick off damaged leaves, or apply dormant oil in early spring, before growth starts.

Leaves, shoots, or seeds distorted. Cause: Boxelder bugs. These ½″ long bugs have charcoal-colored wings with red veins. They feed on leaves, flowers, and fruit and often congregate on tree trunks. Spray plants with superior oil or insecticidal soap when pests first appear.

Leaves skeletonized or with large holes. Cause: Caterpillars. See "Leaves skeletonized or with large holes; branches may be webbed" on page 236 for details.

Leaves with powdery white coating. Cause: Powdery mildew. See "Leaves with powdery white coating" on page 237 for controls.

Leaves with spots. Cause: Leaf spots. See "Leaves with spots" on page 237 for details.

Leaves wrinkled and discolored. Cause: Aphids. See "Leaves wrinkled and discolored" on page 235 for control information.

Branches wilt. Cause: Verticillium wilt. Parts of trees infected with this fungal disease may wilt suddenly or produce leaves that are yellow or smaller than normal. Cut and destroy or dispose of affected branches. Trees may recover if you provide extra water and fertilizer to promote strong, new, healthy growth. Remove severely infected trees; don't replant another maple in the same spot.

Trunk or branches with oozing lesions; branch tips die back. Cause: Canker. See "Trunks or branches with oozing lesions; branch tips die back" on page 238 for details.

Trunk or branches with small holes; limbs die or break off. Cause: Borers. See "Trunk or branches with small holes; limbs die or break off" on page 238 for controls.

Achillea

Yarrow. Perennials.

These hardy, easy-to-grow, mid-border perennials prosper in well-drained soil in full sun. They thrive on heat, need little water once established, and enjoy poor soil. Overly rich soil or excess fertilization gives poor growth and few flowers. Leaves are feathery and grayish green. Tiny yellow, red, or white flowers form dense, broadly flattened clusters from spring to midsummer. Plants form vigorous clumps that can spread; divide regularly for best performance.

Leaves of crowded plants in moist, humid, shady conditions may develop white or gray powdery patches of powdery mildew; see "Leaves covered with white powder" on page 177 for controls. Thin such plants to improve air circulation; avoid watering late in the day.

Aesculus

Horse chestnut. Trees and shrubs.

These deciduous plants have 3″-10″ long, opposite, compound leaves with 3-9 leaflets. The larger species are used as specimens or street trees; the shrubs are best in mass plantings or shrub borders.

All of these species thrive in moist, well-drained soil rich in organic matter. The tree forms do best in full sun, while the shrub kinds will flourish in conditions ranging from full sun to partial shade. Note that insecticidal soap sprays may damage some horse chestnuts; read the label before applying and use with caution. Test spray on a few leaves before spraying the whole plant.

Problems

Leaves with irregular brown spots. Cause: Leaf blotch. Caused by a fungus, these spots may spread over leaves and lead to defoliation. Clean up and destroy fallen leaves to remove overwintering spores.

Leaves with brown, dry edges. Cause: Leaf scorch. This symptom indicates weak or damaged roots or poor soil conditions; it is caused by lack of water or by heat reflected from surrounding pavement. Avoid by planting in rich, evenly moist soil and irrigating, if necessary, in very dry seasons.

Leaves with powdery white coating. Cause: Powdery mildew. See "Leaves with powdery white coating" on page 237 for controls.

Leaves skeletonized. Causes: Whitemarked tussock moths; Japanese beetles. Whitemarked tussock moths are 1½″ long; yellow caterpillar has 4 clumps of white hair on its back, along with 2 tufts of black hair on the head and 1 at the rear. Birds and natural parasites usually keep this pest under control. If damage occurs, reduce future populations by scraping the frothy white egg masses off trunks and branches. Band trunks with a sticky coating, such as Tanglefoot, to catch caterpillars as they crawl up the tree. Spray leaves with BTK to control serious infestations.

Japanese beetles also skeletonize leaves. See "Leaves skeletonized" on page 236 for control measures.

Leaves and shoots blackened; leaves with moist or brown sunken spots. Cause: Anthracnose. See "Leaves and shoots blackened; leaves with moist or brown sunken spots" on page 238 for details on this fungal disease.

Trunk or branches with oozing lesions; branch tips die back. Cause: Canker. See "Trunk or branches with oozing lesions; branch tips die back" on page 238 for details.

Plant defoliated; branches bear cocoonlike bags. Cause: Bagworms. See "Plant defoliated; branches bear cocoonlike bags" on page 236 for controls.

Ageratum

Ageratum, flossflower. Annuals.

The soft lavender, blue, or pink flower clusters of ageratum are a beautiful addition to the flower garden. Plants grow 6″-36″ high and about 1′ wide. They bloom from early summer to first frost. Ageratums also make good container plants.

Direct-seeding ageratum doesn't always give good results. For better germination, sow seeds indoors 8 weeks before the last frost. Seeds need light, so don't cover them; expect germination in about 10 days. Initial seedling growth is slow. Many gardeners prefer the ease of starting with nursery plants.

Ageratum grows best in fertile, well-drained soil on a sunny site with good air circulation. Poor soil and insufficient water cause plant browning. Too much shade causes decreased flowering and legginess. Remove spent flower heads to promote more blooms. Feed plants with a general-purpose fertilizer once a month. The first frost turns plants black.

Problems

Leaves yellow; plant weakened. Cause: Whiteflies. For control measures, see "Leaves yellow; plant weakened" on page 18.

Leaves stippled with yellow; foliage webbed. Cause: Spider mites. See "Leaves stippled with yellow; foliage webbed" on page 18.

Plant wilts. Cause: Fungal wilt. Various fungi thrive in the moist, fertile soil ageratums require. They attack roots, causing plant stunting and wilting. Wilting may begin at lower leaves and progress toward the upper ones, or it may occur rapidly. If the plant is pulled up, you'll see the roots are dark brown and rotting. Discard infected plants. Improve drainage and lighten the soil with organic matter.

Ajuga

Ajuga, bugleweed. Perennials.

These hardy groundcovers favor partial shade and moist, well-drained soil. Flower spikes appear spring to summer over mats of dark green, bronze, or burgundy leaves. Common bugleweed (*Ajuga reptans*) spreads vigorously via stolons, desirable for a slope, less so in a lawn. Other species are more easily controlled. Set plants 6″ apart for rapid coverage.

Excess moisture, especially in heavy, slow-draining soils, encourages crown and root rots caused by soil-dwelling fungi. Dark spots appear on the crown and leaves of infected plants; roots blacken. Controls are cultural: Avoid planting ajuga in wet areas; cultivate to improve air circulation. Remove infected plants and surrounding soil; do not compost diseased plants. Clean up debris in fall to limit places where fungi overwinter.

Albizia

Albizia, mimosa, silk tree. Trees.

Mimosas are deciduous trees growing to 40′ high, with finely textured foliage and pink blooms. They are easy to transplant. Mimosas flower best in full sun. They can adapt to a range of soil conditions.

Because of their insect and disease problems, mimosas are usually short-lived. Mimosa webworms, 1″ long, brown caterpillars, bind leaves with webs and skeletonize foliage. Remove and destroy nests; spray leaves with BTK, or with pyrethrin as a last resort. Mimosa wilt produces wilted leaves and dead branches. Remove and destroy infected trees.

Alcea

Hollyhock. Biennials.

Hardy hollyhocks create an excellent backdrop for a perennial border and offer blooms in shades of red, pink, purple, yellow, and white. Hollyhocks grow 5′-9′ tall, bearing midsummer spikes of fluffy single or double flowers, up to 4″ wide.

Sun-loving and free-flowering, hollyhocks prosper in rich, heavy, moist, well-drained soils, but will thrive in ordinary soils, too. Plant 2′ apart in a site sheltered from wind. Most cultivars require staking.

Problems

Leaf surfaces pale; powdery orange spots beneath. Cause: Rust. Hollyhock's most common disease also deforms leaves and stems and causes early leaf drop. Its orange spots release fungal spores that spread via wind and rain. Grow resistant cultivars; keep leaves dry and encourage good air circulation. In problem areas, apply wettable sulfur several weeks before rust normally appears. Remove and destroy infected plant parts.

Leaves skeletonized. Cause: Leaf-feeding beetles. Japanese beetles are prime suspects here, although other beetles, such as spotted cucumber beetles and rose chafers, may also attack. Handpick or spray with a solution of 1 tablespoon 70 percent isopropyl alcohol to 1 pint prepared pyrethrin mixture. Repeat every 3-5 days until beetles are gone.

Buds and leaves deformed or dwarfed. Cause: True bugs. Several of the true bugs injure hollyhocks with their piercing-sucking mouthparts and release a toxin that deforms plants. See "Buds and leaves deformed or dwarfed" on page 178 for control information.

Allium

Allium. Bulbs.

Related to onions and garlic, but much prettier, ornamental alliums bloom in shades of blue, purple, pink, white, and yellow. Allium foliage may be rounded and hollow like onion leaves or straplike and solid; when bruised, the leaves release the pungent fragrance associated with culinary alliums. The blossoms, however, may have a pleasant floral smell. Small star- or bell-shaped flowers cluster in 2″-9″ globes atop leafless stems in early summer. Plants range from 6″ to 5′ tall.

Plant allium bulbs in fall at a depth roughly 3 times the bulbs' diameter. Select a site with full sun and well-drained soil; taller species may need some protection from wind. Water regularly throughout the growing season, but avoid excess moisture, which encourages rots. Allium foliage dies back shortly after flowering ends. If division is needed to reduce crowding, separate bulblets after foliage dies back; replant immediately.

Problems

Leaves with large, ragged holes. Cause: Slugs and snails. Slugs and snails may feed on foliage; see "Leaves with large, ragged holes" on page 50.

Leaves with silver-white streaks. Cause: Onion thrips. These 1/50″-1/25″ thrips suck sap from foliage; severe infestations stunt plants and may impair flowering. Thrips are hard to control because they burrow into plant tissue. Remove and destroy infested plant parts; encourage predators such as pirate bugs, lacewings, and lady beetles. Clean up debris where thrips overwinter. Monitor and trap thrips with blue sticky traps. Apply insecticidal soap sprays regularly once pests appear on traps.

Copyrighted material

Almond

Prunus dulcis var. *dulcis* (Rosaceae)

Almonds are deciduous trees that grow to about 20′ and bloom in early spring. Nuts are borne on short-lived spurs—short branches that elongate only a fraction of an inch per year. Almonds are hardy in Zones 6-9.

Grow almonds where summers are hot and dry, in sunny sites, free from late spring frosts. To set nuts, many cultivars need cross-pollination; others, such as 'All-in-One,' are self-pollinating. The cultivar 'Archedoise' resists many fungal diseases. Almonds and peaches belong to the same genus and are affected by similar insects and diseases. For more information on problems and solutions, see the Peach entry beginning on page 164.

Problems

Blossoms shriveled, covered with fuzzy gray masses. Cause: Brown rot. Nut hulls also may rot. To control this fungal disease, harvest nuts early, just when hulls begin to split. Before spring growth begins, remove infected nuts and twigs with sunken lesions. For greater control, spray with sulfur or copper.

Nuts disappear. Cause: Squirrels and other pests. For more information, see "Stopping Animal Pests" on page 408.

Growing shoots wilted or dying. Causes: Oriental fruit moths; peach twig borers. Both pests tunnel into growing shoots and cause wilting. For information on controls, see "Growing shoots wilted or dying" on page 166.

Leaves with small purple spots, some spots with centers missing. Cause: Shothole disease. Centers of leaf spots often enlarge to about ¼″, then fall out. For more information on this fungal disease, see "Leaves with small purple spots, some spots with centers missing" on page 167.

Amaranthus

Amaranth. Annuals.

Their colorful leaves or drooping flower clusters make these plants ideal focal points in the garden. They grow from 1′ to 6′ tall, depending on the species and cultivar. The leaves or flowers also stand out in cut flower arrangements.

Amaranth seedlings do not transplant well, so direct-seed in early summer when night temperatures are consistently 60°F or above. Water and feed seedlings regularly only until their colors appear. Thin 1′-2′ apart. Amaranth markedly prefers hot, dry, sunny areas and poor to average soil. Excess fertility causes dull foliage and weak stems. Overwatering leads to root rot, causing stems, crowns, and roots to turn brown or black. Once it begins, there is no cure, so the best control is prevention.

Anemone

Anemone, windflower. Tubers.

Tuberous species of anemones include low-growing Grecian windflower (*Anemone blanda*), a 6″-8″ plant with deeply divided leaves and daisylike, blue, pink, or white flowers, and showy, 7″-15″ poppy anemone (*A. coronaria*), a more tender plant (Zone 8) with single or semidouble blooms in deep shades of red, blue, violet, and white. Both species bloom in early spring.

Soak tubers overnight in warm water before planting in fall. Plant tubers 3″ deep in light shade in richly organic, neutral to slightly alkaline, well-drained soil. Windflower tubers

often lack an obvious top and bottom; plant them on their sides, so stems grow up and roots grow down. Tubers planted sideways have a better chance of growing than those planted upside down. Poppy anemone tubers resemble claws; plant claw side down. Plantings expand slowly. Divide crowded clumps in late summer after foliage dies down, making sure each piece has a bud. Dust with a copper-based fungicide or sulfur and let dry for 2 days in a shady, airy spot before replanting.

Problems

Foliage disappears. Causes: Animal pests; slugs and snails. Birds and rabbits are quite fond of early anemone leaves. Cover young plants with netting if the problem is severe enough to warrant control. See "Stopping Animal Pests" on page 408 for control information.

Slugs and snails also eat anemone leaves; see "Leaves with large, ragged holes" on page 50 for controls.

Leaves, stems, and buds distorted, sticky; clusters of small insects. Cause: Aphids. These tiny pests occasionally trouble anemones. See "Leaves, stems, and buds distorted, sticky; clusters of small insects" on page 51 for control information.

Annuals

Controlling pests and diseases on annual plants is largely a matter of prevention. Annuals die naturally after 1 season, so insect and disease control is less critical than on more permanent plants. Sometimes, though, pest problems can cut short the bloom season and your enjoyment of the flowering annuals, so you'll need to be aware of the few potential problems. Check the individual entries, or see the text below for common problems.

Leaf Problems

Leaves stippled with yellow; foliage webbed. Cause: Spider mites. These tiny, spiderlike pests generally feed on the undersides of plant leaves. They suck sap from plant leaves, initially causing a yellow flecking on the upper leaf surfaces. Severe infestations can cause leaves to turn yellow or white; damaged leaves will eventually turn brown and drop. Tiny webs may be evident on leaves and stem tips.

Control spider mites by spraying plants thoroughly with water (especially the undersides of the leaves) 2-3 times a day for several days. For severe infestations, spray plants with insecticidal soap twice, 2-3 days apart.

Leaves yellow; plant weakened. Cause: Whiteflies. These tiny, white, mothlike flies and their flattened, scalelike larvae feed on leaves, sucking out the plant juices. The adults often fly up in a cloud when you disturb an infested plant. Whiteflies secrete a sugary substance called honeydew, which makes leaves sticky and may encourage the growth of sooty mold fungus; see "Leaves with black coating" below for more information.

Eliminating garden weeds helps keep whitefly populations down. A few yellow sticky traps in the area may catch whiteflies and other pest bugs, but also some beneficials later in the season. Try introducing green lacewings into the garden. Spray leaves with insecticidal soap every 3 days for 2 weeks, paying special attention to lower leaf surfaces. Use pyrethrin as a last resort.

Leaves with large, ragged holes. Cause: Slugs and snails. Slugs and snails range in size from ⅛″ to 8″ and may be gray, tan, green, black, yellow, or spotted. A thick layer of mulch and plants with low-growing leaves provide shady hiding places from which these pests emerge to feed at night. All species rasp

large holes in leaves and stems; slimy trails of mucus also signal their presence.

To deter these pests, sprinkle bands of coarse, dry, scratchy materials, such as cinders, wood ashes, cedar sawdust, and diatomaceous earth, around plants or beds to irritate the soft bodies of these pests; renew frequently. Push 4"-8" copper strips into the soil around beds as edging. Lay boards, cabbage leaves, or overturned clay pots—anything that offers a cool, damp daytime haven—around the garden; destroy pests that congregate underneath. Hand-pick slugs and snails from plants at night; drop them into soapy water or sprinkle them with table salt to dehydrate and kill them. Set out shallow pans of beer; remove drowned pests daily.

Leaves with black coating. Cause: Sooty mold. This fungus grows on the sugary, sticky honeydew produced by aphids, scales, whiteflies, and mealybugs. The black fungal coating doesn't harm leaves directly, but it does shade the leaves and reduce growth.

The best control is to deal with the pests that are producing the honeydew. Determine what pests your plant has and apply the appropriate control. (If the plant itself doesn't show signs of pest damage, the honeydew may be dripping down from an overhanging plant.) On small plants, you can wipe the leaves with a damp cloth to remove the honeydew and the mold.

Leaves with powdery white patches. Cause: Powdery mildew. The powdery leaf patches of this common plant disease consist of fungal strands and spores. The fungus feeds on plant nutrients, causing leaf yellowing. The problem is most common on upper leaf surfaces. Fungus from 1 plant can spread through a crowded area within days.

Encourage good air circulation by thinning plants. Water from below to keep foliage dry. Protect mildew-prone plants, like zinnias, by spraying leaves early in the season with an antitranspirant spray. Pick off infected leaves; remove and destroy seriously infected plants. Spray remaining plants with sulfur or a commercial fungicidal soap spray.

Leaves greenish yellow; growth poor. Cause: Aster yellows. This is a common disease of many annuals. Leafhoppers carry the disease, spreading it through their sap-sucking feeding habits. These tiny, green or brown, wedge-shaped insects move about by running sideways or by hopping. They usually feed on the undersides of plant leaves. Affected plants branch abnormally. Flowers are deformed or absent. Flowers, regardless of original color, turn a yellow-green.

There is no cure. Remove and destroy infected plants. Control leafhoppers by spraying remaining plants with a mixture of insecticidal soap and 70 percent isopropyl alcohol (1 tablespoon alcohol to 1 pint soap solution). Spray 3 times, once every 3 days. Overwatering increases chances of the disease, particularly in heavy soils.

Leaves spotted; buds wilted and dark. Cause: Plant bugs. Tarnished plant bugs are ¼" insects with yellow, black, and red mottling on the wings. Four-lined plant bugs are ¼", yellow bugs with 4 black stripes on their wings. Both pests attack a wide range of ornamentals. Control by handpicking; dust with pyrethrin for serious infestations.

Leaves with spots. Cause: Leaf spots. A large number of fungi and bacteria cause spots on plant leaves, in a variety of colors, shapes, and sizes. In some cases, the spots may spread to cover entire leaves, stunting plant growth.

Fortunately, the same controls are effective against many leaf spot diseases. Remove and discard infected leaves. Thin plants and avoid crowding future plantings. Wash your tools and hands after handling infected plants. Avoid overhead watering. Inspect bedding plants on purchase. Clean up plant debris to remove overwintering sites.

Leaves rolled. Cause: Leafrollers. These ½"-1", green-bodied, brown-headed caterpillars web leaf edges together and feed on the enclosed leaves and buds. If the infestation is light, break open the "envelopes" and pick off the caterpillars; for heavier infestations, spray the leaves with BTK.

Whole Plant Problems

Leaves, stems, and buds distorted. Cause: Aphids. Several species of pear-shaped, 1/32"-⅛" aphids attack annuals. Aphids can be green, pink, black, gray, or with a white fluffy coating and have long antennae and 2 short tubes projecting from the rear of their abdomens. These pests cluster under leaves and on growing tips. Aphids suck plant sap, causing leaf and bud distortion and blossom and leaf drop. Their feeding may spread diseases such as aster yellows. As they feed, they excrete sticky honeydew on which sooty mold grows; see "Leaves with black coating" on page 19 for more information.

Wash aphids from plants by spraying plants with water; repeat as needed to control infestations. Encourage natural predators and parasites. For serious infestations, spray with insecticidal soap, or pyrethrin as a last resort.

Seedlings or young plants cut off at soil level. Cause: Cutworms. These brown or gray, 1"-2" caterpillars feed on plants at night, cutting off transplants and sometimes eating entire seedlings. You'll find severed plants lying on the ground the next morning. Most active in May and June, cutworms can destroy several plants each night. These caterpillars remain below the soil surface during the day.

Protect plants by placing a collar, such as a toilet paper roll or an open-ended can, around each young plant. Push the collar into the soil so that about half is below the surface. Apply parasitic nematodes to the soil.

Leaves and stems with white, cottony clusters. Cause: Mealybugs. At first, mealybugs may be hard to see, but as the plant wilts, and mealybugs rapidly multiply, colonies become quite visible. These minute insects are covered with a fluffy white coating. They suck plant sap and cause the plant to look unhealthy. Mealybugs secrete a sugary substance called honeydew, which makes leaves sticky and may encourage the growth of sooty mold fungus; see "Leaves with black coating" on page 19 for more information.

Control small infestations by spraying them off the plant with water. Insecticidal soap will also control mealybugs; be sure to cover the plant thoroughly.

Seedlings die. Cause: Damping-off. Damping-off is caused by various soil fungi. Sometimes seedling stems rot before they even appear above the surface; in other cases, seedlings are affected after they emerge. The weak, blackened stems will collapse, resulting in seedling death.

Damaged seedlings cannot be cured. To prevent damping-off, let the soil surface dry slightly between waterings. Indoors, run a low-speed fan near your seedlings to promote good air circulation. Outdoors, thin seedlings to avoid overcrowding. Do not add nitrogen fertilizers until seedlings have produced their first true leaves.

Antirrhinum

Snapdragon.
Tender perennials grown as annuals.

Most gardeners try snapdragons at least once, and many make them a garden mainstay. Bloom time is winter and spring in mild winter areas, and spring to summer elsewhere. Snapdragons prefer cool weather but tolerate heat. Single or double upright flower spikes offer a variety of color choices, including red, white,

yellow, orange, and pink. Height range is 4″-48″. Plants may self-sow.

Start seeds indoors in late summer or early fall in mild climates and in early spring where frosts are common. Do not cover seeds; they require light and warmth for germination. Seedlings appear in 7 days. Move seedlings outside in spring when the planting bed can be worked. Direct-seeding outdoors is possible, but seeds dry out rapidly, so frequent sprinkling is necessary. Purchased bedding plants flower faster than home-grown plants because of the controlled growing conditions.

Place plants 6″-12″ apart in full sun and humus-rich, well-drained, somewhat sandy soil. To keep plants from becoming leggy or spindly, pinch them back when they are 3″-6″ high. Pinching may cause a slight flowering setback at first, but later, flower production will markedly increase. Give ample water from below. Fertilize once a month. Cut flower spikes frequently to maintain bloom. When flowering slows down, cut plants back severely and give liquid fertilizer. In windy areas, staking may be necessary.

Problems

Stems and leaf undersides with dusty, dark brown spots. Cause: Rust. This fungus develops quite rapidly, so leaves must be monitored for initial spotting. Rust-resistant snapdragons are now available and should be used whenever possible. However, they don't eliminate the problem.

Infections are less likely if snapdragons are grown rapidly and vigorously. Keeping the soil evenly moist will encourage strong, healthy growth. If rust spotting appears, or if you have had rust problems in prior years, dust every 2 weeks with sulfur, beginning in very early spring. Fertilize and water regularly, but avoid overhead watering, which helps transfer rust spores. Water in mornings. Remove and destroy badly infected plants. In severe situations, where rust appears in succeeding years despite controls, change planting locations.

Leaves, stems, and buds distorted. Cause: Aphids. See "Leaves, stems, and buds distorted" on the opposite page for controls.

Leaves stippled with yellow; foliage webbed. Cause: Spider mites. For control measures, see "Leaves stippled with yellow; foliage webbed" on page 18.

Apple

Malus spp. (Rosaceae)

Apples are deciduous trees growing from 6′ to more than 30′, depending on soil, rootstock, and cultivar. The showy, pink-tinged white blossoms appear in spring mostly on spurs—short branches that elongate only a fraction of an inch per year. Apples are hardy in Zones 3-9.

Culture

Plant in full sun in well-drained, moderately fertile, slightly acidic soil. Train trees to a framework of well-spaced, wide-angled branches. Prune bearing trees each winter to admit light into the tree and encourage good air circulation. As you prune, remove diseased and spindly wood and crossed branches. Where dense growth blocks out light, remove extra shoots at their bases. To develop growth on spindly shoots, remove the end of the shoot just above an outward-facing bud. For more pruning information, see "Pruning and Training" on page 101. For best results, choose cultivars resistant to a wide range of diseases. These include 'Jonafree', 'Liberty', 'Nova Easy Grow', 'Priscilla', 'Redfree', and 'William's Pride'.

To set fruit, most cultivars need cross-pollination by a second compatible apple or crab apple planted within 40'-50'. Some cultivars, such as 'Jonagold' and 'Mutsu', pro-

duce nonviable pollen and can't serve as pollinators. A few, like 'Golden Delicious', are self-pollinating. If you're planting 1 tree, improve fruit set by grafting a branch of a suitable pollinator onto the tree. For more information on setting fruit, see "Setting Fruit" on page 101.

Fruit Problems

Fruit with holes surrounded by brown, crumbly excrement. Cause: Codling moths. Adults appear in early spring and lay eggs in trees within 2-6 weeks of blossom time. Eggs hatch into larvae within 5-14 days. The fat, white or pinkish, 7/8" caterpillars tunnel through fruit and may be gone by the time you find the holes, which may be filled with what looks like moist sawdust. For light infestations, kill eggs by spraying superior oil on leaves and twigs within 2-6 weeks of blossoming. For heavy infestations, kill larvae before they tunnel into fruit by spraying the tree canopy with pyrethrin at petal fall and again 10-14 days later. Mixing pyrethrin spray with a synergist (see "The Other Ingredients" on page 469) can improve control. For additional details on codling moth's life cycle and controls, see "Coordinated Control" on page 262.

Codling moths often produce several generations per growing season. Trapping the pupating caterpillars aids control. Remove loose bark and wrap the trunk with a band of corrugated cardboard or burlap. Periodically remove the band and destroy pupae. Also inspect harvest containers for pupae.

Since codling moths prefer crowded fruit, you can discourage attack by thinning apples until no fruit touches. Infested apples may drop early; pick up and destroy dropped fruit before larvae emerge to pupate. If you have a single backyard tree and no other trees in your area, try trapping male moths with pheromones. Mating disruption pheromones are also available. Since females rarely fly more than 100 yards looking for host plants, plant your trees well away from other apple, pear, or walnut host trees in your area.

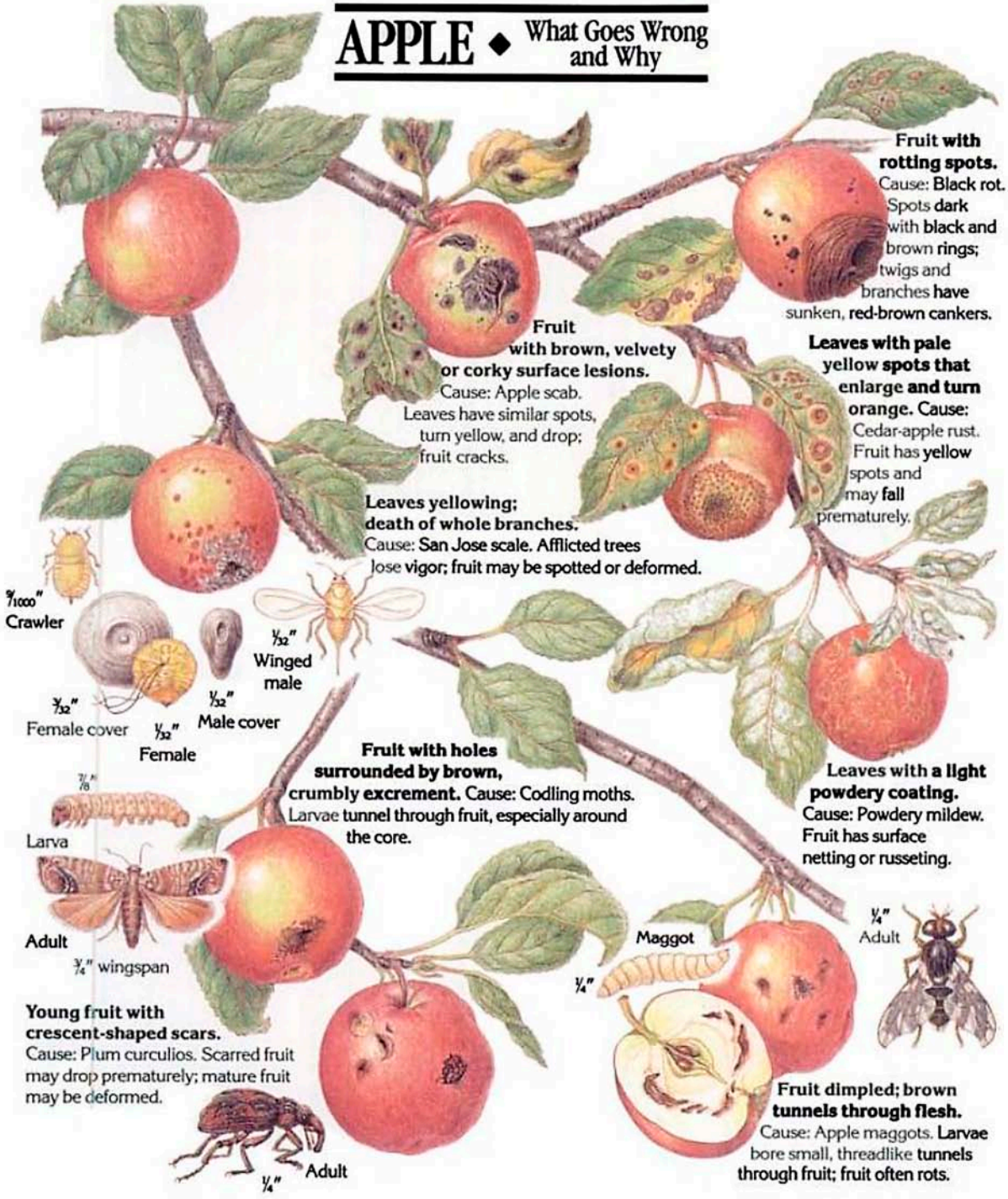
The effectiveness of other controls depends on local conditions. Introduced *Trichogramma* wasps control this pest in some orchards but not in others. Success depends on such factors as weather, optimum timing of parasite release, and using the correct species of wasp. If you'd like to try this technique, be sure to purchase a species of *Trichogramma* that parasitizes codling moths. BTK may also help with control, but you have to apply it during the 3-5 days between the time when the eggs hatch and the larvae enter the fruit. Once the larvae are in the fruit, BTK is ineffective. You may find that BTK is more effective when combined with a feeding attractant (also called an appetite stimulant), such as molasses. See the opposite page for an illustration of this pest.

In the future, gardeners may be able to buy new experimental codling moth control products, such as codling moth granulosis virus. Another experimental product, encapsulated BTK, releases the bacteria through a timed-release capsule for potential long-term control of codling moth larvae. Also, cultivars resistant to codling moths may eventually be available.

Fruit dimpled; brown tunnels through flesh. Cause: Apple maggots. These 1/4" larvae of the apple maggot fly ruin fruit by copious tunneling. Adult flies emerge from soilborne pupae in late June and continue to appear until early autumn. Flies puncture fruit skin and deposit eggs, which hatch into fruit-tunneling maggots. Infested apples often drop. To prevent buildup of pupae around trees, collect and destroy dropped fruit at least weekly.

Apple maggot flies are attracted to fruit by sight. You can control them by trapping them on dark red balls coated with a sticky coating, such as Tangle-Trap. Buy commercially made traps or make your own from discarded croquet balls. In mid-June hang 1

APPLE ◆ What Goes Wrong and Why


Fruit with rotting spots. Cause: Black rot. Spots dark with black and brown rings; twigs and branches have sunken, red-brown cankers.
Fruit with brown, velvety or corky surface lesions. Cause: Apple scab. Leaves have similar spots, turn yellow, and drop; fruit cracks.
Leaves with pale yellow spots that enlarge and turn orange. Cause: Cedar-apple rust. Fruit has yellow spots and may fall prematurely.
Leaves yellowing; death of whole branches. Cause: San Jose scale. Afflicted trees lose vigor; fruit may be spotted or deformed.
9/1000" Crawler
1/32" Winged male
1/32" Male cover
3/32" Female cover
1/32" Female
Fruit with holes surrounded by brown, crumbly excrement. Cause: Codling moths. Larvae tunnel through fruit, especially around the core.
Leaves with a light powdery coating. Cause: Powdery mildew. Fruit has surface netting or russeting.
Larva
Adult
3/4" wingspan
1/4" Adult
Maggot
1/4"
Young fruit with crescent-shaped scars. Cause: Plum curculios. Scarred fruit may drop prematurely; mature fruit may be deformed.
Adult
1/4"
Fruit dimpled; brown tunnels through flesh. Cause: Apple maggots. Larvae bore small, threadlike tunnels through fruit; fruit often rots.

trap per dwarf tree or 4-8 traps per full-size tree. Hang traps at eye-level, 2′-3′ in from branch tips, near fruit but not completely hidden by leaves. Clean traps every few days and reapply the sticky coating. See page 23 for an illustration of this pest.

Young fruit with crescent-shaped scars. Cause: Plum curculios. This beetle, common east of the Rocky Mountains, leaves a characteristic crescent-shaped scar as it lays eggs in fruit. Damaged apples may drop, but frequently will remain on the tree. Since plum curculios cannot mature in hard apple flesh, fruit that doesn't drop will be superficially scarred but otherwise edible.

To control this pest without sprays, spread a dropcloth beneath the tree and jar the trunk and branches with a padded mallet. Collect and destroy curculios that fall onto the sheet. For best results, jar the tree twice a day, beginning as soon as you see the first scarred fruit. In addition, prevent hatching of some curculio eggs by picking up and discarding dropped fruit. Some apples ('Mutsu', for example) are more resistant to plum curculios than others. In the future, breeders may be able to develop other apple cultivars with even greater curculio resistance. For more information, see "Young fruit with crescent-shaped scars" on page 186. See page 23 for an illustration of this pest.

Fruit with brown, velvety or corky surface lesions. Cause: Apple scab. This serious, widespread disease begins when spring warmth and moisture promote the discharge of fungal spores from old, infested apple leaves into the air. These spores can infect the leaves and fruits of susceptible apples growing nearby. To prevent scab from spreading into the tree each spring, destroy dropped leaves in the fall. Either collect and compost leaves in a hot compost pile or hasten their decay on the ground by shredding them with a lawn mower. You may also till leaves into the soil or spray them with a nitrogen source, such as blood meal, to speed decomposition.

Growing-season applications of copper, sulfur, or lime-sulfur sprays will help control scab. If you have susceptible cultivars or if the weather is very warm and wet, spray weekly beginning with the appearance of the first green tips on the tree until disease pressure subsides. Pruning to encourage sunlight penetration and air circulation also helps with control. Scab-resistant cultivars include 'Golden Delicious', 'Grimes Golden', 'Jonagold', 'Jonathon', 'Mutsu', 'Spigold', and 'York'.

In the future gardeners may be able to treat fallen leaves with a fungus such as *Athelia bambacina,* which inhibits development of overwintering apple scab. See page 23 for an illustration of apple scab.

Fruit with rotting spots. Cause: Summer disease. Summer diseases are fungal diseases associated with hot weather. Dark spots with alternating black and brown rings indicate black rot. Other summer diseases include bitter rot (slightly sunken, tan spots) and white rot (watery decay). Black rot prevails where summers are cool; bitter rot and white rot, where summers are warm. Summer disease fungi overwinter in mummified fruit and in cankers on diseased wood. To control, remove and dispose of all cankered wood. Collect and destroy mummified fruit. Black rot and white rot attack weakened or wounded trees, so keep them healthy with good pruning and nutrition. Prune in early spring, when wounds heal most quickly. Sulfur sprays help control black rot (see page 23 for an illustration). Cultivars resistant to bitter rot include 'Akane', 'Blairmont', 'Fuji', 'Hawaii', 'Jonafree', 'Jonalicious', 'Liberty', 'Melrose', 'Priscilla', and 'Spartan'. Cultivars resistant to white rot include 'Akane', 'Arkansas Black', 'Arkansaw', 'Dayton', 'Fuji', 'Hawaii', 'Jonafree', 'Jonalicious', 'Liberty', 'Limbertwig', and 'Melrose'.

Fruit with yellow skin spots that later turn orange. Cause: Cedar-apple rust. Infected fruit is small, deformed, and may fall prematurely. For more information see "Leaves with pale yel-

low spots that enlarge and turn orange" below.

Fruit with surface netting or russeting. Cause: Powdery mildew. For more information, see "Leaves with a light powdery coating" below.

Fruit with red skin spots bearing white centers. Cause: San Jose scale. For more information, see "Leaves yellow; death of whole branches" on page 26.

Fruit with raised black spots or brown smudges on the surface. Causes: Fly speck; sooty blotch. Black spots are fly speck; brown smudges are sooty blotch. Both of these blemishes are fungal diseases and both can be controlled with sulfur sprays. But since both are superficial, you can just rub them off the fruit.

Leaf and Branch Problems

Leaves with olive-brown, velvety spots that become brown and corky. Cause: Apple scab. Infected leaves may turn yellow and drop prematurely, further weakening the tree. For more information see "Fruit with brown, velvety or corky surface lesions" above.

New leaves twisted or curled and covered with a sticky coating. Cause: Aphids. You may find these tiny green, black, gray, pink, or white fluffy-coated insects on leaf undersides. The leaves may be covered with a black coating, caused by a fungus called sooty mold that feeds on the honeydew exuded by aphids. Aphids weaken trees by sucking sap, but they depart by midsummer. For a light infestation, just wait it out. Also grow nectar-producing flowers, such as dill and buckwheat, near your trees to provide food for aphid predators (parasitic wasps, lady beetles, and hover flies). Or attract aphid predators by spraying commercial or homemade yeast-and-sugar mixtures on your trees. For more information, see "New leaves twisted or curled and covered with a sticky coating" on page 67.

Leaves with pale yellow spots that enlarge and turn orange. Cause: Cedar-apple rust. Leaves infected with cedar-apple rust may drop prematurely. This fungal disease overwinters as a gall on various juniper species—commonly on Eastern red cedar (*Juniperus virginiana*). In the spring the galls swell, push out orange horns, and discharge disease spores that are borne on the wind to infect apple trees. The leaf spots caused by cedar-apple rust won't spread disease into the tree, and you can't make them go away once they appear.

Cedar-apple rust isn't a problem in areas with few Eastern red cedars or other junipers (*Juniperus* spp.). Removing nearby Eastern red cedars won't prevent the arrival of windborne disease coming from trees miles away. Sulfur sprays are only fairly effective. Resistant cultivars include 'Arkansas Black', 'Empire', 'Gala', 'Granny Smith', 'Gravenstein', 'Grimes Golden', 'Jerseymac', 'McIntosh', 'Macoun', 'Tydeman's Red', and 'Winesap'. See page 23 for an illustration of this disease.

Leaves with a light powdery coating. Cause: Powdery mildew. As this fungal disease becomes more severe, leaves may curl lengthwise and drop. Since it overwinters in dormant buds, winter pruning of infected buds, which show white fungal growths, aids control. Spray sulfur for growing-season control. Resistant cultivars include 'Empire', 'Golden Delicious', 'McIntosh', 'Mutsu', 'Red Delicious', 'Rhode Island Greening', and 'Spigold'. See page 23 for an illustration of this disease.

Leaves suddenly blacken, with tips of growing shoots bent over. Cause: Fire blight. Don't confuse this disease with sooty mold, a black fungus that rubs off easily. Fire blight bacteria may travel to roots and kill the entire tree. For growing-season control, remove blighted parts at least 6″ below the infected area. Between cuts, dip tools into isopropyl alcohol or 10 percent bleach solution (1 part bleach to 9 parts water). Resistant cultivars include 'Arkansas Black', 'Baldwin', 'Ben Davis', 'Empire', and 'Winesap'. For more information, see "Leaves suddenly blacken, with tips of growing shoots bent over" on page 170.

Whole Plant Problems

Leaves yellow; death of whole branches. Cause: San Jose scale. Clusters of these sucking insects cling to bark and appear as small gray bumps that can be easily scraped off with a fingernail. Control with late winter application of dormant oil spray. See page 23 for an illustration of this pest.

Fruit disappears; bark gnawed. Causes: Deer; rabbits; mice. For information on controlling these pests, see "Stopping Animal Pests" on page 408.

Tree declines; sawdustlike material on trunk near ground level. Cause: Roundheaded appletree borers. These creamy white, dark-headed larvae bore into trunks near ground level, girdling the tree or tunneling into the heartwood. Kill borers by inserting a thin, flexible wire or by injecting parasitic nematodes into the hole.

Apricot

Prunus armeniaca (Rosaceae)

Apricots are deciduous trees growing 20′-30′. The pink blossoms appear in spring on spurs—short branches that elongate only a fraction of an inch per year—1 year old and older. Apricots are hardy in Zones 4-9.

Plant in a sunny site with well-drained, moderately fertile soil and protected from late frost. Train young trees to a modified central leader; for complete instructions, see the illustration on page 102. Most apricots are self-pollinating, but some cultivars bear more if cross-pollinated. For more information, see "Setting Fruit" on page 101. Apricots and peaches belong to the same genus and have similar problems. For more information on problems and solutions, see the Peach entry beginning on page 164.

Problems

Young fruit with crescent-shaped scars. Cause: Plum curculios. These beetles, common east of the Rockies, leave characteristic scars as they lay eggs in fruit. Damaged fruit usually drops. For information on controls, see "Young fruit with crescent-shaped scars" on page 186.

Fruit with small brown spots that enlarge and grow fuzzy in humid weather. Cause: Brown rot. Blossoms attacked by this fungal disease also may wither, fruit may mummify (dry and shrivel) on the tree, and leaves may turn brown. Resistant cultivars include 'Harcot', 'Hargrand', and 'Harlayne'. For more information, see "Fruit with small brown spots that enlarge and grow fuzzy in humid weather" on page 166.

Fruit with small, dark, sunken spots or cracks on skin. Cause: Bacterial leaf spot. This disease, common in the Southeast, is very difficult to control. Plant resistant cultivars, including 'Alfred', 'Curtis', 'Harcot', 'Hargrand', and 'Harlayne'. For more information, see "Fruit with small, dark, sunken spots or cracks on skin" on page 166.

Fruit with pinkish worms. Cause: Oriental fruit moth larvae. For more information on this pest, which also tunnels into growing shoots, see "Growing shoots wilted or dying" on page 166.

Growing shoots wilted or dying. Causes: Oriental fruit moth larvae; peach twig borers. Both pests tunnel into growing shoots and cause wilting. For more information, see "Growing shoots wilted or dying" on page 166.

Leaves with small purple spots, some spots with centers missing. Cause: Shothole disease. Centers of leaf spots often enlarge to about ¼″, then fall out. This fungal disease, common in the West, spreads rapidly on wet foliage.

For more information, see "Leaves with small purple spots, some spots with centers missing" on page 167.

Tree declines; gummy exudate mixed with sawdustlike material on trunk near ground level. Cause: Peachtree borers. Inspect the trunk near or just below the ground; you may find holes and a gummy exudate made by peachtree borers, which are the larvae of a clear-winged moth that bore the inner bark. For information on controls, see "Tree declines; gummy exudate mixed with sawdustlike material on trunk near ground" on page 168.

Branches wilting and dying, fail to leaf out in spring. Causes: Bacterial canker; Valsa canker. Both diseases may cause amber gum to exude from the bark. The cultivars 'Harcot', 'Hargrand', 'Harlayne', and 'Harogem' are resistant to Valsa. For more information, see "Branches wilting and dying, fail to leaf out in spring" on page 167.

Aquilegia

Columbine. Perennials.

Columbines brighten spring and summer with blossoms of yellow, white, purple, red, or bicolor. Plants reach 1′-3′ and bear 1″-4″, spurred flowers.

Plant these woodland natives in moist, organic, well-drained, slightly acid soil. Overly rich soil causes weak, short-lived plants, lush growth, and few flowers. Plants tolerate full sun if temperatures stay below 80°F but prefer light shade. Set plants 1′ apart in spring after the last frost or in fall when plants are dormant, placing crowns at soil level. Columbines have long roots; only young plants transplant easily. To start from seed, sow outdoors in early summer or indoors in winter. Don't cover the seed; it needs light to germinate. Columbines self-seed, but seedlings may not match the parents. Mulch lightly in cold winter areas.

Problems

Leaves with tan or brown blotches or serpentine tunnels. Cause: Leafminers. These tiny pale green fly larvae feed between the upper and lower leaf surfaces. Prune off and destroy infested leaves. Remove debris in fall to destroy overwintering leafminers. Let parasitic wasps control these pests, or apply weekly insecticidal soap sprays starting when the first tunnel appears.

Stems blacken at base; leaves yellow; plant topples over. Cause: Fungal and/or bacterial rots. Prevent with cultural practices: Plant only in well-drained sites; avoid crown or root injuries from careless digging. Keep winter mulch away from crowns to prevent rotting during dormancy. Remove affected plants and surrounding soil; don't compost them.

Arabis

Rock cress. Perennials.

These low-growing, spreading plants are often used as groundcovers, in rock gardens, and as border edging; few species grow over 1′ tall. Rock cresses prefer soil on the dry side, cool temperatures, and full sun. White, pink, or rose flowers appear in early spring.

Summer heat can cause rock cresses to die out in the center, a condition best prevented with good growing conditions. Divide mature plants in spring in most areas. Space plants 5″ apart. Cut back after flowering to

encourage dense growth. Apply a winter mulch in cold areas. If thrips, mites, or aphids cause leaf yellowing, knock them from plants with a strong water spray. Time watering so plants have dried by nightfall; wait until soil is fairly dry before respraying. Overwatering encourages rot, as does poor drainage.

Artemisia

Artemisia, wormwood. Perennials.

This genus includes southernwood (*Artemisia abrotanum*), wormwood (*A. absinthium*), and tarragon (*A. dracunculus*). Durable and sometimes woody, most species are grown for their feathery, gray-green to silver foliage. Plants given full sun and average, well-drained soil suffer few problems. Rich soil promotes rangy growth; excess moisture encourages root rot. Mounding types such as silvermound artemisia (*A. schmidtiana*), often react to high temperatures by dying out in the center; cut stems back to about 1″ tall to encourage overall new growth. Artemisias' aromatic oils repel most insects.

Asparagus

Asparagus officinalis (Liliaceae)

Asparagus is a long-lived perennial. Its tender young shoots are one of the first vegetables ready to harvest in the spring.

Culture

Asparagus is hardy in Zones 2-9. It thrives in any area with winter ground freezes or a dry season to provide a dormant period each year. Asparagus does best in full sun and deep, well-drained soil. Select a permanent location carefully, since plants will produce for 20 years or more. Dig out all weeds and add plenty of compost to the soil before planting. Asparagus requires high levels of phosphorus, potassium, and nitrogen. Do a soil test and add amendments as necessary. If your soil is heavy or poorly drained, plant asparagus in raised beds.

Plant 1-year-old crowns from a reputable nursery that sells fresh, firm, disease-free roots, or start your plants from seed. Soak seeds or crowns in compost tea for 5 minutes before planting to reduce disease problems.

Most seed-grown asparagus plants eventually out-produce those started from crowns. Growing from seed also allows you to eliminate female plants. A bed of all male plants can produce as much as 30 percent more spears than a mixed bed of male and female plants. Plants grown from seed will flower their first summer. When the tiny flowers appear, observe them with a magnifying glass. Female flowers have well-developed, 3-lobed pistils; male blossoms are larger and longer than female flowers. Weed out all female plants. The following spring, transplant the males to the permanent bed.

Harvesting new plantings too soon can stress plants and make them more susceptible to pest problems. Harvest for 2 weeks the second season, 4 weeks the third season, and up to 8 weeks thereafter.

Mulch with a high-nitrogen compost each spring before spears emerge, and again in fall. Leave winter-killed foliage, along with straw or other light mulch, on the bed to provide winter protection. Remove and destroy the

foliage before new growth appears in the spring; it can harbor diseases and pest eggs. Over the years, the crowns will push closer to the soil surface, resulting in smaller and less-tender spears. To remedy this, mound 6″ of soil over the rows each spring.

Spear Problems

Spears small. Causes: Young plants; low soil fertility; overharvested plants. Harvest lightly the first few years so plants can grow strong roots. Reduce harvest if established plantings begin to lose vigor. Asparagus is a heavy feeder; add lots of compost to maintain high soil fertility.

Spears small with brown streaks or girdled at soil line. Cause: Asparagus miners. Larvae are 3/16″ long, white maggots. Adults are small black flies. Destroy infested spears to control.

Spears turn brown, may get soft or wither and dry. Cause: Cold injury. Cut and discard damaged spears. Cover spears with mulch or newspaper when freezing nights are predicted.

Spears small, with large lesions at or below soil line. Cause: Fusarium wilt. Leaves and stems yellow, plants wilt, seedlings die. There is no cure; remove and destroy infected plants. To avoid problems, don't put new plantings where asparagus or other Fusarium-susceptible plants have grown in 8 years. Plant disease-free seed and crowns or resistant cultivars such as 'Greenwich', 'Jersey Giant', 'Martha Washington', and 'Viking KB3'. Disinfect seed before planting. Soak it for 2 minutes in a 10 percent bleach solution (1 part bleach to 9 parts water), and rinse for 1 minute under running water.

There are reports that adding rock salt to asparagus soil at 2 pounds per 100 square feet may suppress Fusarium infection and improve asparagus root growth.

Spears turn brown near soil line. Cause: Crown rot. Remove and destroy diseased plants, including roots. Prevent crown rot by planting in raised beds and maintaining good drainage. Keep soil pH above 6.0. Wait 2 years before harvesting new plantings. Some research suggests that not harvesting the first spear of the spring on each plant may help prevent crown rot because the developing frond produces food for the plant.

Spears crooked and deformed, may be brown, or scarred; leaves chewed or missing. Causes: Asparagus beetles; asparagus fern caterpillars; cucumber beetles; mechanical injury. Asparagus beetles are blue-black, 1/4″ long insects with cream-colored spots and red borders on wing covers. Larvae are 1/3″ long, humpbacked, gray grubs with black heads. They are most active in cool weather. Spotted asparagus beetles are reddish orange with 12 black spots on wing covers. Larvae are orange. Fertilize plants to encourage new leaf growth. Apply a commercial pyrethrin spray or dust to control beetles. Destroy tops in late winter to remove overwintering beetles and future problems.

Asparagus fern caterpillar (also known as the beet armyworm) feeds on leaves. It is a dull green, 1 1/2″ long caterpillar with a light-colored stripe along each side of the body. Handpick or spray with BTK to control.

Cucumber beetles also eat asparagus leaves. For description and controls, see "Leaves with chewed holes" on page 215.

Deep cultivation can damage developing spears. Cultivate shallowly or use mulch instead. In windy areas, blowing sand can scar spears; protect plantings with windbreaks.

Spears chewed at soil line. Cause: Cutworms. Check for cutworms at night with a flashlight. Control with BTK or parasitic nematodes. See "Seedlings clipped off at soil line" on page 246 for more controls.

Spear bracts open prematurely (feathering). Cause: Excessive heat. Harvest spears daily when they are about 8″ high, especially when temperatures are above 95°F.

Leaf Problems

Leaves yellow; growth slow. Causes: Nitrogen deficiency; waterlogged soil. Spray foliage with fish-meal tea and side-dress with compost to correct nitrogen deficiency. Waterlogged soil will produce the same symptoms. Make sure soil is well-drained or plant in raised beds.

Leaves yellow; plant dwarfed or rosetted. Cause: Asparagus aphids. These soft-bodied, pale green, powdery-looking insects suck plant juices and cause plants to weaken. Knock aphids off plants with a strong blast of water, or spray with insecticidal soap. If that fails to control the problem, apply a commercial pyrethrin spray or dust.

Leaves turn brown and drop; stems and branches have small reddish blisters. Cause: Rust. Clean up and dispose of tops in late winter to eliminate overwintering spores. Rust weakens plants by reducing the leaf area and the amount of food stored in the roots. Repeated attacks can kill plants. Plant resistant cultivars such as 'California 500', 'Jersey Giant', 'Martha Washington', 'Mary Washington', 'Rutgers Beacon', 'Viking KB3', and 'Waltham Washington'.

Leaves dull gray-green to brown. Cause: Thrips. Adults are tiny, pale, rapidly moving, winged insects. The larvae are smaller, wingless versions barely visible with the naked eye. Trap thrips with sticky traps or spray with insecticidal soap. Research indicates that blue and yellow sticky traps are the most effective thrips catchers in greenhouses. Other studies suggest that thrips are most attracted to white sticky traps outdoors. Hang traps slightly higher than the tops of the plants.

Aster

Aster, Michaelmas daisy. Perennials.

Daisylike aster flowers of purple, pink, or white appear in late summer and fall on plants that range from 9″ to 6′ in height.

Asters require ample water—about 1″ per week—but also need well-drained soil and a sunny location. Plants will self-sow with abandon if fading flowers are not removed; seedlings aren't usually true to parent type. Grow tall cultivars out of wind and stake as needed. Divide in spring every 2-3 years.

Problems

Leaves, stems, and buds distorted, sticky; clusters of small insects. Cause: Aphids. For controls, see "Leaves, stems, and buds distorted, sticky; clusters of small insects" on page 177.

Leaves and/or flowers with holes. Cause: Japanese beetles. See "Leaves and/or flowers with holes" on page 176 for controls.

Leaves covered with white powder. Cause: Powdery mildew. For controls, see "Leaves covered with white powder" on page 177.

Leaves and flowers deformed, yellowish; small, tarlike spots on undersides. Cause: Lace bugs. These small pests with lacy wings cause yellow-brown leaf spots. Dark brown droppings on lower leaf surfaces confirm their activity. Remove debris in spring and fall to deter overwintering. For severe problems, spray superior oil, insecticidal soap, or pyrethrin.

Leaves with pale areas on upper surfaces; "downy" patches underneath. Cause: Downy mildew. This fungus spreads quickly during cool, wet nights and warm, humid days, causing leaves to wilt and die. Remove and destroy infected plant parts, encourage air circulation, and water early in the day to allow plants to dry before nightfall.

Astilbe

Astilbe, false spirea. Perennials.

Astilbes' dark green to bronze, fernlike foliage appears in spring, followed by pink, white, purple, or red plumelike flower spikes. These mid-border plants grow 1′-3′ tall with a similar spread.

Astilbes enjoy the soggy soil conditions shunned by most other perennials, although good drainage is needed if winters are wet. Use a 3″ layer of mulch around plants to conserve water. Never let soil dry completely—this causes brown-edged leaves and poor growth. Set plants 1′ apart in partial shade and rich soil. Astilbes benefit from spring fertilization and light feedings during the growing season. Divide every 3-5 years.

Grown under the conditions described above, astilbes suffer few pest or disease problems beyond those common to herbaceous perennials.

Problems

Leaves and/or flowers with holes. Cause: Japanese beetles. See "Leaves and/or flowers with holes" on page 176 for controls.

Leaves covered with white powder. Cause: Powdery mildew. Crowding under moist conditions invites powdery mildew. For control information, see "Leaves covered with white powder" on page 177.

Plant wilts while soil is moist. Cause: Fusarium wilt. *Fusarium* spp. fungi sometimes infect astilbes, causing wilting unrelated to adequate soil moisture. Young plants wilt quickly, while older ones turn pale green and lower leaves wilt. Stems show brown streaks that darken gradually; grayish pink mold may appear. Remove and destroy infected plants and surrounding soil; do not compost diseased materials. Don't plant susceptible crops in sites where wilt has appeared. Sterilize tools after use around infected plants.

Avocado

Persea americana (Lauraceae)

Avocado trees grow to about 60′ and have long, drooping leaves. Though evergreen, some trees shed their leaves just before a growth flush. Each tree bears many thousands of flowers, but pollination of only a small percentage of flowers ensures a full crop. Avocados are mostly self-pollinating. They are hardy to Zone 10.

Avocados need full sunlight and well-drained soil. Pruning is only necessary to keep a tree within bounds and to remove diseased wood.

Problems

Fruit with brown or purplish, scablike lesions. Cause: Fruit scab. Scab is a superficial skin fungus and not otherwise harmful to the plant. No treatment is necessary unless infection is so severe that fruit is deformed. For severe infection, apply copper sprays in early May and twice more at 4-5 week intervals.

Fruit gnawed or eaten. Causes: Birds; squirrels; rats; other small animals. Use traps or physical barriers to get rid of rodents; netting may be necessary for birds. See "Stopping Animal Pests" on page 408 for more information on controlling pests.

Leaves skeletonized and webbed together. Causes: Avocado caterpillars; omnivorous leafroller caterpillars. The yellowish green avocado caterpillar (also called an amorbia) is

Copyrighted material

the larva of a reddish brown moth. Omnivorous leafrollers, yellowish green caterpillars with a stripe down their backs, are the larvae of dark brown moths. Natural enemies, such as *Trichogramma* wasps, often keep these pests sufficiently in check. For heavy infestations, spray BTK. Also look for and crush caterpillars and masses of eggs.

Leaves wilt and yellow on an entire branch. Cause: Verticillium wilt. A soilborne fungus causes this disease, and there is no way to save a tree once it has this problem. Don't plant avocados in soil that has sustained other Verticillium-susceptible crops such as tomatoes, peppers, and eggplants. If you suspect *Verticillium* fungi may be in your soil, solarize it for 1-2 months over the summer before planting Verticillium-susceptible plants.

Leaves pale green to yellow and dropping. Cause: San Jose scale. Look for the small, ash-colored to sooty black bumps of San Jose scale clinging to the bark. Colonies of these sucking, immobile insects cling to bark and weaken trees by sucking sap. Control scale with dormant oil spray applied in late winter.

Tree declines; stunted pale leaves; no new growth. Cause: Root rot. Root rot can be caused by overwatering or by poorly drained soil, but the disease may take years to develop. There is no cure. Replant in well-drained soil or on a raised mound of soil. 'Grande' and 'Martin' are rootstocks resistant to this problem.

B

Basil

Ocimum basilicum (Labiatae)

Basil is an annual herb grown for its aromatic leaves. To grow healthy, trouble-free plants, sow seed indoors in 70°F soil mix, or outdoors after the soil has warmed. Basil does best in rich, moist, well-drained soil with a pH between 5.0 and 8.0, and needs at least 4 hours of full sun per day for good growth.

Basil is rarely troubled by pests or diseases. Protect plants with row covers when temperatures drop below 40°F, or dark spots caused by cold injury may appear on leaves. Fungi may also cause dark spots on foliage. Remove spotted leaves and spray foliage with compost tea or sulfur if problem is severe. If leaves are mottled yellow with turned-down edges, plants may have cucumber mosaic virus. Destroy infected plants. See the Herbs entry beginning on page 116 for other problems.

Bean

Phaseolus spp. (Leguminosae)

Beans are annual vegetables grown for their immature pods, immature seeds, and nutritious dry seeds. They are legumes and, with the help of certain soil-dwelling bacteria, can transform nitrogen from the air into nitrogen compounds that plants can absorb. A wide range of bean types and cultivars are available.

Culture

Beans thrive in most soil. Work in plenty of low-nitrogen compost before planting to loosen the soil. For a healthy, trouble-free crop, plant beans after soil has warmed. Optimum soil temperature for germination is 80°F. At soil temperatures below 60°F, most bean cultivars germinate poorly and are more susceptible to pests and root rot. Choose light, well-drained soil for early plantings, if possible, and cover beans with row cover or clear plastic until they emerge. If you use clear plastic, be sure to remove it as soon as the seeds germinate to avoid "cooking" the seedlings.

Beans do best when soil pH is between 5.5 and 6.8. They don't require high soil fertility. In fact, high nitrogen levels will delay maturity. Spray young plants with seaweed extract to prevent micronutrient deficiencies and improve overall plant health.

Soak seed in compost tea for 25 minutes before planting to help prevent disease and speed germination. Treat seed with an inoculant labeled for the type of bean you are planting before sowing to promote nitrogen fixation. Be sure to buy fresh inoculant each year, or check the date on the package for viability.

Don't touch plants when foliage is wet to avoid spreading diseases. Compost plants after harvest. Prevent problems by not planting beans in the same location more often than every 3 years.

Whole Plant Problems

Seedlings die or fail to emerge; plant stunted. Causes: Seedcorn maggots; root rot. Look for 1/4" long, yellow-white maggots feeding on seeds and seedlings. Adults are small flies. Seedlings that do come up are deformed and spindly. Control these soil-dwelling pests by applying parasitic nematodes to the soil before replanting.

Root rot causes reddish black streaks on the roots; plants are stunted and yellow. Cool, wet soil encourages this fungal disease. Destroy wilted plants. Replant with fresh seed in well-drained, warm soil. Soak seed in compost tea before planting.

Plant yellow and stunted, wilts during hot days and recovers at night. Causes: Wireworms; bean leaf beetle larvae; root knot nematodes. If you suspect any of these pests, pull up a plant and examine the roots. Wireworm larvae are up to 1 1/2", yellow to reddish brown, slender, tough-bodied, segmented grubs. Adults are 1/2" long, dark-colored, elongated click beetles. Apply parasitic nematodes to the soil to control.

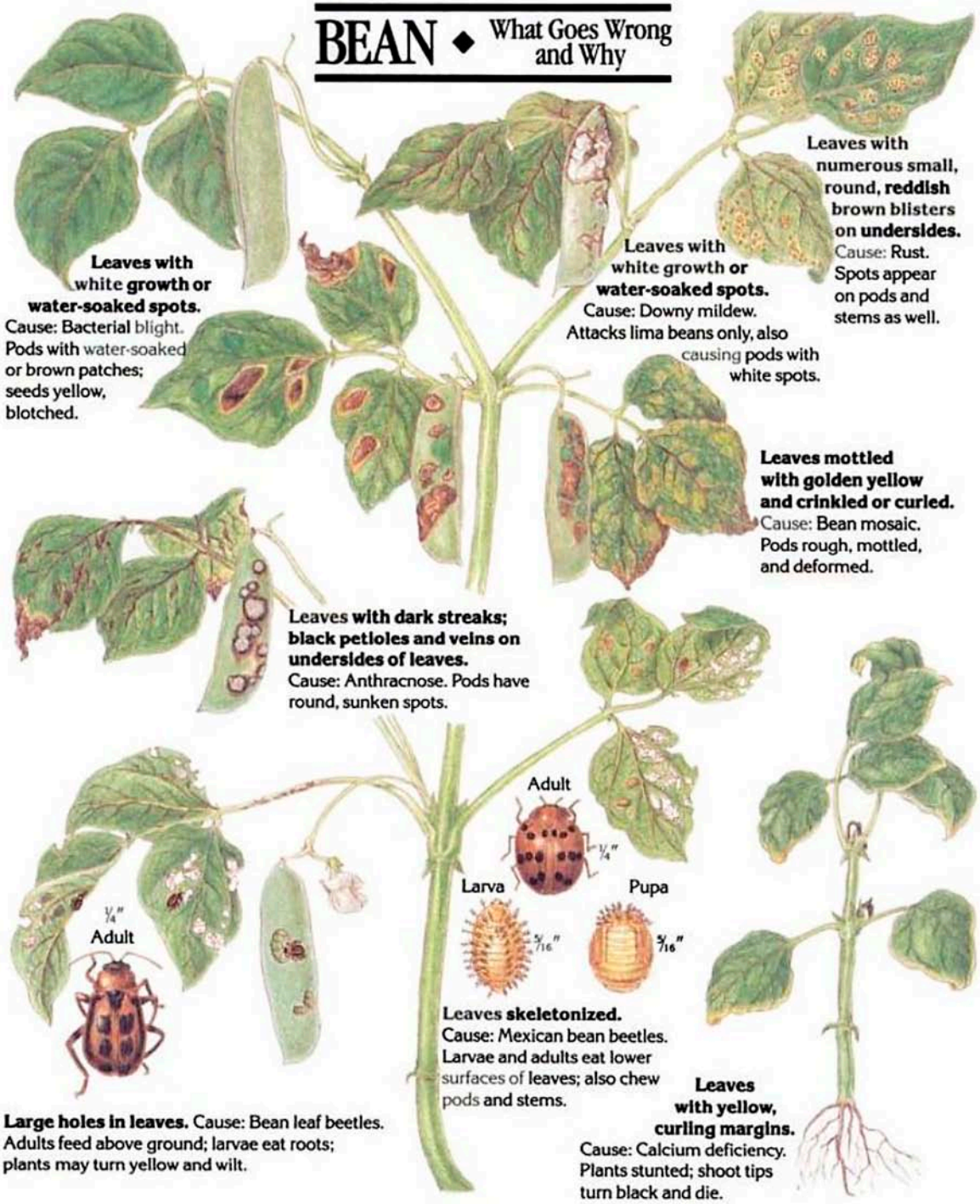
Slender white grubs up to 1/3" long feeding on roots are bean leaf beetle larvae. See "Leaves with large holes" on page 36 for more information.

Root knot nematodes cause swollen and darkened enlargements of roots. Destroy infested plants. Control root knot nematodes by applying chitin or parasitic nematodes to the soil. Small, round, pinkish nodules attached to the roots are caused by nitrogen-fixing bacteria and are beneficial.

Leaf Problems

Leaves with yellow, curling margins. Causes: Potato leafhoppers; calcium deficiency; salt injury. Look for leafhoppers on plants. Adults are 1/10", yellow-green, winged insects.

BEAN ◆ What Goes Wrong and Why


Leaves with white growth or water-soaked spots. Cause: Bacterial blight. Pods with water-soaked or brown patches; seeds yellow, blotched.
Leaves with white growth or water-soaked spots. Cause: Downy mildew. Attacks lima beans only, also causing pods with white spots.
Leaves with numerous small, round, reddish brown blisters on undersides. Cause: Rust. Spots appear on pods and stems as well.
Leaves mottled with golden yellow and crinkled or curled. Cause: Bean mosaic. Pods rough, mottled, and deformed.
Leaves with dark streaks; black petioles and veins on undersides of leaves. Cause: Anthracnose. Pods have round, sunken spots.
Adult
1/4"
Larva
5/16"
Pupa
5/16"
Leaves skeletonized. Cause: Mexican bean beetles. Larvae and adults eat lower surfaces of leaves; also chew pods and stems.
1/4"
Adult
Large holes in leaves. Cause: Bean leaf beetles. Adults feed above ground; larvae eat roots; plants may turn yellow and wilt.
Leaves with yellow, curling margins. Cause: Calcium deficiency. Plants stunted; shoot tips turn black and die.

Nymphs are smaller and wingless. Severe infestations cause plants to wilt and flowers and pods to drop. Leafhoppers can spread viruses from plant to plant, so control is important. Cover emerging seedlings with row cover if leafhoppers have been a problem. Spray plants with insecticidal soap in the evening to control. If that is not effective, spray or dust with pyrethrin. Controls are most effective on wingless nymphs since adults fly away when disturbed. Be sure to spray the undersides of leaves where nymphs congregate.

Salt injury is common in areas of the country with saline soils, because beans are very sensitive to sodium. Planting in raised beds (with lots of compost worked in) and watering thoroughly may help.

If plants are also stunted and shoot tips turn black and die, suspect calcium deficiency. See the opposite page for an illustration of this problem. Keep soil evenly moist to help prevent problems. If soil test shows deficiency, add gypsum, or calcitic lime if pH is below 6.2.

New growth distorted and yellow. Cause: Tarnished plant bugs. Adults are oval, light green to brown, 1/4" long bugs. Nymphs are smaller and yellow-green. Trap them with white sticky traps, or spray with pyrethrin in the evening to control.

Leaves yellow; growth stunted. Cause: Nitrogen deficiency. This problem is often brought on by waterlogged soil. Spray foliage and drench roots with fish emulsion or fishmeal tea to alleviate symptoms. Prevent problems by adding compost to the soil and providing good drainage.

Leaves yellow and withered. Cause: Bean aphids. Adults are small, black, soft-bodied, sucking insects. For mild infestations, knock pests off plants with a blast of water. Spray plants with insecticidal soap if aphid populations are low, or with a commercial neem or pyrethrin solution if more than half the shoot tips have aphids.

Leaves mottled with golden yellow and crinkled or curled. Cause: Bean mosaic. Leaves of infected plants curl downward, and plants are stunted. Seeds are small and shriveled. See the opposite page for an illustration of this disease. Remove and destroy plants infected with this viral disease. Prevent problems by controlling aphids that spread the disease and by planting tolerant cultivars, such as 'E-Z Pick', 'Goldcrop', 'Lake Largo', 'Morgane', 'Provider', 'Roma 2', 'Sungold', 'Tendercrop', 'Topcrop', and 'Venture'.

Leaves puckered and curled downward; plant dwarfed. Cause: Curly top virus. Remove and destroy infected plants. Prevent problems by controlling aphids that spread the disease and by planting resistant or tolerant cultivars such as 'Goldcrop', 'Great Northern', and 'Hystyle'.

Leaves with white growth or water-soaked spots. Causes: Downy mildew; powdery mildew; white mold; bacterial blight. Warm, damp weather encourages these diseases, the first 3 of which are caused by fungi. Downy mildew only attacks lima beans, causing young shoots and flowers of infected plants to develop white growth; leaf veins are twisted and purplish. See the opposite page for an illustration of downy mildew. Powdery mildew and white mold can attack all types of beans. Leaves develop a powdery or fuzzy white coating.

To control fungal diseases, thin plants to increase air movement. If weather is wet, spray sulfur in the evening. Plant cultivars, such as 'Provider' and 'Tendercrop', that tolerate all 3 diseases. Under some conditions, a baking-soda-and-soap spray (1 teaspoon baking soda, 1 teaspoon liquid dish soap, 1 quart water) may prevent further infection.

Water-soaked spots caused by bacterial blight turn brown with a yellow halo and then become dry and brittle. See the opposite page for an illustration of this disease. Spray plants with copper to reduce the spread of the dis-

ease if plants are setting fruit. If no new pods are forming, don't bother to spray; remove and destroy infected plants.

Leaves with dark streaks; black petioles and veins on undersides of leaves. Cause: Anthracnose. Spots exude salmon-colored ooze in cool, moist weather. See page 34 for an illustration of this fungal disease. This disease thrives in wet, humid conditions. Spray plants with sulfur to control. Prevent problems by planting tolerant cultivars such as 'Espada', 'Marbel', 'Morgane', and 'Rocdor'.

Leaves with numerous small, round, reddish brown blisters on undersides. Cause: Rust. As this fungal disease progresses, leaves turn yellow and drop. Spots also appear on pods and stems. See page 34 for an illustration of this disease. Rust usually develops in late summer. To control, spray sulfur as soon as you see indications of the disease. Plant cultivars that are rust-tolerant, such as 'Burpee Stringless', 'Kentucky Wonder', 'Roma', 'Spurt', and 'Sungold', to prevent problems.

Leaves pale and stippled or bronzed. Cause: Mites. Hot, dry weather encourages outbreaks. Look for these tiny, spiderlike creatures on the undersides of leaves where they appear as pale or dark specks. There may be a fine webbing on the undersides of leaves. To control, spray plants with water or insecticidal soap in the evening.

Leaves with wandering, white or translucent tunnels. Cause: Leafminers. Adults are tiny black-and-yellow insects. Larvae are pale green and maggotlike and tunnel into leaves. Remove and destroy mined leaves. Apply row cover as soon as plants emerge to prevent problems. Use yellow sticky traps to catch adults. Certain parasitic nematodes can actually attack leafminer larvae inside leaf tunnels.

Leaves riddled with tiny holes. Cause: Flea beetles. These small, shiny, black beetles hop when disturbed. Treat plants with a commercial pyrethrin spray or dust if damage is severe. Prevent problems by covering young plants with row cover.

Leaves skeletonized. Cause: Mexican bean beetles. See page 34 for an illustration of this pest. In severe infestations pods also are chewed. Adults are oval, 1/4" long, yellowish brown beetles with 16 black spots on the wing covers. Nymphs are yellowish orange and spined. Eggs are yellow and found in groups on the undersides of leaves. A tiny parasitic wasp, *Pediobius foveolatus*, provides effective control. Release the wasps when there are bean beetle larvae present. In cold climates you must release the wasps each year as they cannot overwinter. Spined soldier bugs are also efficient predators. Spray or dust with pyrethrin as a last resort.

Leaves with large holes. Causes: Bean leaf beetles; cucumber beetles; various caterpillars. Bean leaf beetles are 1/4" long and dark yellow with 6 black dots. The larvae are white, up to 1/3" long, and feed on roots and underground stems. Cucumber beetles are 1/4" long and greenish yellow with black stripes or spots. Prevent problems by covering plants with row cover. If beetle damage is severe, treat leaves with a commercial neem or pyrethrin spray. See page 34 for an illustration of bean leaf beetle; see page 214 for an illustration of cucumber beetle.

Many caterpillars also feed on bean leaves. Spray plants with BTK to control.

Flower and Pod Problems

Blossoms appear but no pods form. Causes: Excessive heat; mechanical injury; zinc deficiency. Hot days (85°F or more) or mechanical damage caused by heavy rains or strong water sprays can cause flowers to drop. Wait for new blossoms.

Zinc deficiency can also cause pods to drop. Spray plants with seaweed extract to prevent deficiency problems.

Pods with dark, round, sunken spots with lighter centers. Cause: Anthracnose. Salmon pink ooze appears in wet weather. See "Leaves with dark streaks; black petioles and veins on undersides of leaves" above for controls.

Pods with water-soaked or brown patches; seeds yellow and blotched. Cause: Bacterial blight. See "Leaves with white growth or water-soaked spots" on page 35 for controls.

Pods with white spots. Causes: Powdery mildew; white mold; downy mildew. See "Leaves with white growth or water-soaked spots" on page 35 for more information and controls. Lima bean pods infected with downy mildew shrivel and turn black.

Pods rough, mottled, and deformed. Cause: Bean mosaic. See "Leaves mottled with golden yellow and crinkled or curled" on page 35 for controls.

Pods with wartlike pimples. Cause: Green stink bugs. Adults are large, flat, shield-shaped, green bugs. Nymphs have reddish markings. Handpick adults to control mild infestations. For control if injury is severe, spray or dust plants with pyrethrin.

Pods with chewed holes. Cause: Caterpillars. Cover plants with row cover to exclude egg-laying moths if caterpillars have caused damage in the past. Control feeding worms with BTK spray.

Pods pitted and browned. Cause: Cold injury. Most cultivars may be damaged at temperatures below 45°F. Protect late crops with row cover.

Dry beans tunneled. Cause: Bean weevils. Adults are gray or brown, 1/10"-1/8" long snout beetles. Larvae are small and light-colored. To control this storage pest, dry seed in a 125°F oven for 25 minutes, or store at 0°F for 3-4 days to kill larvae.

Beet

Beta vulgaris
Crassa group (Chenopodiaceae)

Beets are biennial vegetables grown for their firm, sweet roots and succulent greens. Cultivars with red, yellow, and red-and-white roots are available.

Culture

Beets grow best in deep, well-drained soil with a pH between 6.5 and 7.5. They are a cool-season plant and will tolerate temperatures as low as 40°F. However, plants will bolt if exposed to 2-3 weeks of temperatures below 50°F after the first true leaves have formed. Beets grow poorly above 75°F and are best grown as a spring or fall crop. Keep soil moist, but not soggy since rapid and uninterrupted growth produces the best roots. Prevent problems by not planting beets in the same location more often than every 3 years.

Leaf Problems

Leaves with purplish patches. Cause: Phosphorus deficiency. This is common in cool spring soils. Plants usually outgrow problem when soils warm. Spray leaves with seaweed extract to speed up recovery.

Leaves yellow; plant stunted. Cause: Nitrogen deficiency. This deficiency affects older leaves first. Spray foliage and drench roots with fish emulsion to alleviate symptoms.

Leaves yellow and curled; plant stunted. Cause: Aphids. Adults are soft-bodied, small, green, gray, black, or pinkish sucking insects, sometimes with a white fluffy coating. Knock aphids off the plants with a blast of water, or spray plants with insecticidal soap to control. If soap spray is not effective, apply a commer-

cial neem or pyrethrin spray.

Leaves with brown tips. Cause: Excessive heat. Bright sun and 80°F temperatures may injure beet leaves. Plant in a partially shaded location or provide shade in climates with hot summers.

Leaves with dark-bordered, tan spots. Cause: Cercospora leaf spot. Destroy spotted leaves. Spray plants with copper if this fungal disease is severe to prevent further spread, or before symptoms develop if it has been a problem in the past. To prevent problems, soak seed in 122°F water for 25 minutes before planting. (Be aware that this treatment can damage seed viability; for complete instructions, see page 422.) Eliminate weeds that can harbor the disease. Plant cultivars, such as 'Big Red Hybrid' and 'Red Ace', that are tolerant of this disease.

Leaves with light-colored spots on upper leaf surfaces. Cause: Downy mildew. Leaves infected with this fungal disease have spots covered with white fuzzy growth on the undersides. Spray plants with copper when symptoms first appear.

Leaves stunted and crinkled. Cause: Curly top virus. There is no cure once plants are infected; destroy infected plants. Leafhoppers spread the virus as they feed; control them with sprays of insecticidal soap, or for severe infestations, neem or pyrethrin. Prevent problems by covering seedbed with row cover after planting.

Leaves with wandering, white or translucent tunnels. Cause: Leafminers. Pale green, maggotlike larvae feed inside leaves, leaving empty tunnels behind them. Adults are tiny black-and-yellow insects. Once larvae have entered leaves, spraying will not control them. Destroy mined leaves. Catch adults with yellow sticky traps. Prevent problems by covering plants with row cover as soon as they emerge. Certain parasitic nematodes can attack leafminer larvae inside leaf tunnels.

Leaves riddled with small holes. Cause: Flea beetles. These small, shiny, black, brown, or bronze beetles hop when disturbed. Prevent problems by covering plants with row cover as soon as they emerge.

Leaves with large, ragged holes. Causes: Beet armyworms; garden webworms. Greenish brown, 1½" long caterpillars with a light-colored stripe on each side are beet armyworms. Pale green to nearly black, 1" long caterpillars with a black or light stripe down their backs and dark spots are garden webworms. Webworms roll leaf edges over. Handpick or spray actively feeding caterpillars with BTK in the evening.

Root Problems

Roots distorted, with rough, cracked skin. Cause: Downy mildew. See "Leaves with light-colored spots on upper leaf surfaces" above for controls.

Roots with raised, rough, brown spots on surface. Cause: Scab. Prevent this fungal disease by adding compost to soil, and plant in raised beds to improve drainage.

Roots with black, dead, hard spots in flesh. Cause: Boron deficiency. Roots may be wrinkled or cracked. Plants can be stunted; leaf edges may be brown and lower leaf surfaces may be reddish purple. Prevent deficiency problems by spraying plants with seaweed extract as soon as the first true leaves appear, and every few weeks thereafter. Check deficiency with a soil test. Correct by adding 1 tablespoon of borax dissolved in 1 gallon water, or 10 pounds of kelp, per 100 square feet of soil.

Roots forked. Cause: Calcium deficiency. Prevent problems by keeping soil evenly moist. If soil test shows deficiency, add gypsum, or if pH is below 6.2, calcitic lime.

Roots small and poorly developed. Causes: Nitrogen deficiency; crowded roots. If leaves are small and yellow, feed plants with fish emulsion or compost tea to boost nitrogen

level. Thin plants so roots don't touch to allow further growth.

Roots covered with hairy side roots; flesh woody. Cause: Curly top virus. See "Leaves stunted and crinkled" above for controls.

Roots unusually dark-colored. Cause: Potassium deficiency. Affected roots are prone to rot. If soil test confirms deficiency, amend soil as needed.

Roots light-colored; zoned rings in flesh very evident. Causes: Excessive heat; uneven soil moisture. Prevent problems by keeping soil evenly moist and mulching with straw during hot weather.

Begonia

Begonia. Tender perennials grown as annuals, and tubers.

The genus *Begonia* provides many beautiful species that are well-adapted to garden culture. Outdoors, the most common types are the fibrous-rooted and tuberous-rooted begonias. Each type has its own habits and needs.

The fibrous-rooted wax begonia, with its prolific flowering habit, is among the most popular bedding plants. Clusters of single or double, pink, white, or reddish flowers, up to 2″ across, appear in spring and continue until frost. Wax begonias do not always compete successfully with other annuals. Spotlight them in masses of 1 color. These are good plants to line the front of a sunny or partially shady border, growing only 6″-9″ tall and up to 1′ wide. In mild climates they may overwinter and live for years. They do well in window boxes and are widely grown as flowering and ornamental houseplants. Glossy wax begonia leaves are shades of green or red.

Tuberous-rooted begonias have fewer but larger and more showy blooms. The single or double flowers can grow to 6″ or more across. They bloom on upright plants, growing to 2′ tall, in bright and pastel shades of white, pink, red, yellow, and combinations. Tuberous-rooted begonias brighten up shady beds and borders.

Because powdery wax begonia seeds require much nurturing, many gardeners prefer to buy bedding plants in spring for direct garden placement. If you do decide to grow your own, sow the tiny seeds indoors, 5 months before the final frost. Use a mix of fine peat and sand as the medium. Fluorescent lighting helps keep the desired warm temperature. Water seedlings from the bottom. When they are large enough to handle, transfer to 3″ pots; transplant outdoors when night temperatures remain above 50°F. Set plants 9″ apart.

Start tuberous-rooted begonias indoors, planting them 8-10 weeks before your frost-free date in a loose growing medium. Barely cover tubers with the concave side up (it should have little pink buds coming out of the center) and moisten lightly. Give lots of water and light after the shoots emerge. Move tubers to individual 4″ or 5″ pots when shoots are 1″-3″ tall. After all danger of frost is past, plant in partial shade in fertile, moist but well-drained soil with plenty of organic matter. Water liberally in warm weather. Feed every 3 weeks or so with compost tea or fish emulsion.

Begonias need rich, very well drained, light soil. Work in generous amounts of leaf mold, dehydrated manure, humus, and bonemeal. They tolerate full sun in cool climates only; in hot climates, leaves in full sun may show dry spotting from sunscald. Heavy shade, however, results in legginess and fewer flowers. Partial shade is generally best. Water when soil 1″ below surface is still moist but not wet. Fertilize every 3-4 weeks.

If you want to overwinter tuberous-rooted begonias, lift the plants (with the soil still

attached) in fall when the leaves are yellow and withered. After a week or so, cut the stems to within a few inches of the tuber. Once the stem stub dries completely, shake the soil off the tubers and store in dry peat or coarse sand at 45°-55°F. Start them again in spring.

Some gardeners dig up favored garden wax begonias, bringing them indoors before first frost to use as houseplants, then making cuttings in spring for garden use. As houseplants, begonias may bloom most of the year. Pinch back stems by at least half to promote new growth. Keep soil damp but not wet. Mist leaves occasionally. Keep in sun or some shade. When bringing any plant indoors from outdoors, consider that you also may be transferring pests and diseases indoors. These can spread rapidly to other household plants.

Problems

Leaves with powdery white patches. Cause: Powdery mildew. This fungal disease is very common on begonias. For control information, see "Leaves with powdery white patches" on page 19.

Flower buds drop off. Causes: Excess water; high temperatures. Poor drainage and overwatering are the prime causes of early bud drop. Ease up on the watering and plant begonias in humus-rich soil with good drainage next time. Overly high temperatures also cause bud drop. In areas with unexpected hot spells, mulch roots and mist plants in late morning.

Leaves with angular brown blotches. Cause: Leaf nematodes. Microscopic, wormlike creatures, known as leaf nematodes, may be feeding on the affected leaves. They cause brown blotches that enlarge until the leaves curl up and drop off. Symptoms usually appear on lower leaves first and spread to upper leaves. Plant growth is stunted; new leaves may not appear.

Remove and destroy infested leaves and the next 2 leaves directly above them. Do not let affected plants touch unaffected ones. Water from below rather than above; nematodes can move from one plant to another through water. Leaf nematodes can survive 3 or more years in the soil or surrounding debris. If you have a problem, don't replant begonias in that area.

Leaves with fuzzy, brown or gray spots. Cause: Botrytis gray mold. The Botrytis fungus tends to attack weak plants. Once the resultant gray mold takes hold, the disease moves into healthy plant tissue. High humidity and cool temperatures favor the infection process, as do crowded plantings, rain, and overhead watering. Botrytis gray mold fungus can be a year-round problem in mild winter areas. Remove and destroy infected leaves, stems, and flowers. Thin plants to encourage good air circulation.

Leaves with spots. Cause: Leaf spots. Both bacteria and fungi cause leaf spots on begonias. Bacterial leaf spot produces small blisters that are brown with yellow margins; fungi may form brown, black, or transparent spots. For control information, see "Leaves with spots" on page 19.

Leaves, stems, and buds distorted. Cause: Aphids. See "Leaves, stems, and buds distorted" on page 20 for controls.

Leaves yellow; plant weakened. Cause: Whiteflies. For controls, see "Leaves yellow; plant weakened" on page 18.

Leaves and stems with white, cottony clusters. Cause: Mealybugs. See "Leaves and stems with white, cottony clusters" on page 20 for control information.

Stems with soft, water-soaked spots. Cause: Stem rot. Both bacterial and fungal infections can cause begonia stems to rot. If you catch the stem spots when they are small, try cutting them out with a razor blade or sharp knife. Remove and destroy seriously

infected leaves, stems, and plants. These diseases can spread quickly, so wash your hands and tools after working with infected plants. Avoid overcrowding and overhead watering; pick a site with good air circulation. Keep mulch a few inches away from the stem. Don't replant begonias in affected areas.

Leaves with reddish brown lines. Cause: Thrips. These tiny, light brown, fast-moving insects generally attack leaves, causing reddish brown lines or spots on upper leaf surfaces and silvery blotches on leaf undersides. Stems, buds, and flowers can also be affected. Remove and destroy severely infested plants.

Leaves with large, ragged holes. Cause: Slugs and snails. See "Leaves with large, ragged holes" on page 18 for controls.

Berberis

Barberry. Shrubs.

Barberries are spiny deciduous or evergreen shrubs commonly used as hedges, barriers, or foundation plants.

Barberries grow in sun or partial shade and prefer well-drained soil. They require little care and tolerate even severe pruning. Set out container-grown or bare-root plants in spring or fall.

Pests and diseases are seldom a problem on cultivated barberries. Many states prohibit growing common barberry (*Berberis vulgaris*), which is an alternate host to a rust fungus that also attacks cereal grains. Check with your extension agent for local restrictions.

Problems

Leaves and shoots blackened; leaves with moist or brown sunken spots. Cause: Anthracnose. See "Leaves and shoots blackened; leaves with moist or brown sunken spots" on page 238 for control suggestions.

Leaves wrinkled and discolored. Cause: Aphids. See "Leaves wrinkled and discolored" on page 235 for control measures.

Leaves chewed; branch tips with webbing. Cause: Barberry webworms. These 1½", black caterpillars tie together leaves and twigs, forming a web nest in midsummer as they feed on the leaves. If not too numerous, remove nests by hand. Control large infestations with 3 applications of BTK made 1 week apart, or spray with pyrethrin.

Leaves shrivel and turn brown. Cause: Barberry wilt. This soilborne fungus attacks water-conducting tissue, causing leaves to wilt and eventually killing the entire plant. Remove the whole affected plant and its surrounding soil; replace with fresh soil.

Leaves with notched leaf margins. Cause: Japanese weevils. The ¼", brown adults attack foliage, and the legless white grubs feed on roots. Apply a sticky substance, such as Tanglefoot, to the lower stems to prevent adults from climbing up the plants. Drench the soil around the base of the plant with a solution of parasitic nematodes to control the larvae. Spray leaves several times with pyrethrin for major infestations of adults.

Twigs covered in small reddish brown bumps. Cause: Barberry scale. Heavy infestations may cause yellowing foliage and stunted growth, leading to the death of the plant. Pests are most active in June and July. Spray twigs with dormant oil in early spring, before growth starts. During the growing season, spray plant with superior oil or repeated applications of insecticidal soap.

Whole plant stunted and lacking vigor. Cause: Nematodes. See "Whole plant stunted and lacking vigor" on page 239 for more information.

Bergenia

Bergenia. Perennials.

Bergenias are sturdy, low-growing border plants with rose-pink flower clusters borne above the foliage in early spring. Broad, glossy leaves are 10″ long and heart-shaped in the case of heartleaf bergenia (*Bergenia cordifolia*), oval in the case of leather bergenia (*B. crassifolia*). The foliage takes on a dark burgundy color in fall; leaves are evergreen but often damaged by cold weather. Space plants 1′-1½′ apart in average, well-drained soil in a partially shaded spot.

Bergenias' large, low leaves form a haven for slugs and snails. See "Leaves with large, ragged holes" on page 177 for control information.

Betula

Birch. Trees.

Birches are deciduous trees with simple leaves. They are popular as single or multiple-stemmed specimen trees; attractive features include their striking trunks, peeling bark, graceful branches, and magnificent fall color.

Most birches grow best in cool climates and almost invariably perform better in the northern portions of their range. Choose a site with light shade and moist but well-drained, acidic soil. Transplant in spring as balled-and-burlapped specimens. Don't prune in winter or early spring, when trees can "bleed" sap; late summer is a better time.

Birches are relatively short-lived, especially when stressed, and they are beset by a number of insect pests that can cause serious damage and even loss. Fortunately, you can prevent most of the common problems by planting trees in the right conditions and keeping them vigorous. Fertilize regularly, and water deeply during drought. Some species, such as river birch (*Betula nigra*), are less prone to common birch pests.

Those species that are noted for their predominantly white bark develop this characteristic slowly: do not be disturbed if the young plant you have acquired is not white when you get it!

Problems

Leaves blister and turn brown. Cause: Birch leafminers. Perhaps the most serious and prevalent of all birch pests, birch leafminers produce ¼″, white larvae that feed between the upper and lower surfaces of the leaves. Several generations occur each year; the first, usually active in May, is most destructive. Remove infested leaves. Repeated applications of insecticidal soap will kill the small, black, sawflylike adults, reducing future populations.

Leaves yellow; branch tips dead or dying; trunk with lumps under bark. Cause: Bronze birch borers. The adults are ½″-1″, blunt-headed, reddish gray beetles that feed on the foliage, and then lay their eggs in slits in the bark. The eggs hatch into light-colored grubs that tunnel through the bark into the sapwood, starting from the top of the tree and working downward. By the time you see the symptoms, it is usually too late to save the tree. If the damage is not yet severe, you could try pruning out and destroying the infested parts. The best control for borers is planting trees in the right conditions and keeping them healthy and vigorous. Avoid planting European white birch (*B. pendula*), which is very susceptible to this pest.

Leaves skeletonized. Causes: Canker-

worms; birch skeletonizers; Japanese beetles. Cankerworms are ½"-1", yellow, green, or brown caterpillars that feed on the foliage of birches, often defoliating the tree. To avoid this problem, apply a band of a sticky substance, such as Tanglefoot, around the base of the tree in spring to keep females from climbing up the tree and laying their eggs. Apply fresh coats in September and February to trap both spring and fall cankerworms. If their feeding becomes a problem, spray with BTK as soon as you notice them, and continue every 2 weeks until the pests are gone.

Birch skeletonizers also feed on foliage, leaving brown leaves with visible leaf veins behind. These ¼", yellowish green caterpillars do the most damage in July and August. In most cases this pest is a problem only every few years, and the damage happens so late in the season that no control is necessary. If you want to protect young trees from serious damage, apply BTK or superior oil as soon as you spot pests in midsummer.

Japanese beetles are foliage feeders, too. For information on controlling them, see "Leaves skeletonized" on page 236.

Plant defoliated. Cause: Gypsy moths. See "Plant defoliated" on page 236 for control suggestions.

Trunk or branch crotches with swollen, cracked lesions. Cause: Canker. This fungal disease attacks at the forks of branches, causing swellings that crack open to expose the wood. The callus tissue that forms may also be affected. The canker can eventually girdle and kill the branch or tree. If the canker is small, cut out the tissue involved; cut down and destroy seriously infected trees. Healthy trees are less susceptible.

Leaves tunneled. Cause: Leafminers. See "Leaves tunneled" on page 237 for controls.

Leaves wilt or curl and pucker. Cause: Birch aphids. These small, pear-shaped insects attack the foliage, weakening and distorting the growth. They also produce copious quantities of honeydew, which attracts ants and encourages the growth of black-colored, sooty mold. Spray plants with a strong jet of water to knock off the pests. For serious infestations, apply insecticidal soap, or pyrethrin spray as a last resort.

Branches die. Cause: Dieback. This fungal disease produces symptoms very similar to those caused by bronze birch borers, except for the lumpy bark. Trees weakened by drought, low fertility, or borers are most susceptible to infection. Prevent this problem by planting trees in the right spot and watering during drought to keep them growing vigorously. If symptoms do occur, prune out and destroy or dispose of infected branches.

Leaves with powdery white coating. Cause: Powdery mildew. See "Leaves with powdery white coating" on page 237 for controls.

Leaves with spots. Cause: Leaf spots. See "Leaves with spots" on page 237 for control suggestions.

Blackberry

Rubus spp. (Rosaceae)

Blackberries are perennials that bear fruit on second-year canes. Some cultivars grow erect and some bear long, trailing canes. Blackberries are hardy in Zones 5-8.

Like other bramble fruits, blackberries need full sun and well-drained, moisture-retentive soil. Train plants to posts or fences. Prune annually. Pull unwanted suckers. On erect blackberries pinch the tips of 3′ canes to force growth of lateral shoots. During the dormant season, shorten all lateral shoots to about

1½′. For both types of blackberry, cut away all fruiting canes right after harvest. In winter thin out canes leaving 3 or 4 canes per clump for erect types and 8-12 canes per clump for trailing types.

Blackberries are self-pollinating and require no cross-pollination to set fruit. Blackberries belong to the same genus as raspberries and are affected by similar insects and diseases. For more information on problems and solutions, see the Raspberry entry beginning on page 196.

Problems

Flowers with reddish, twisted petals; no fruit set. Cause: Double blossom. Double blossom, known as rosette, also causes plants to throw out witch's brooms, dense masses of deformed twigs with pale leaves. To control this fungal disease, remove infected canes as soon as you notice them. To help prevent the spread of the fungus, spray the whole planting with copper 2 or 3 times at 10-day intervals. If the disease is rampant, mow down the whole planting and destroy the newly cut canes. Avoid planting sites near wild brambles, which may carry the disease. Resistant cultivars include 'Flordagrand' and 'Humble'.

Fruit covered with light gray fuzz. Cause: Fruit rot. Especially common during wet weather, this fungal disease appears less frequently where plants have good air circulation and proper pruning. To control fruit rot, harvest berries often. Also pick and discard infected fruit far away from plants.

Fruit fails to ripen or remains red and sour. Cause: Redberry mites. Control these microscopic mites with lime-sulfur applied in early spring when new shoots are 1″ long and again when canes have about 1′ of new growth.

Canes and leaves with purple spots. Causes: Anthracnose; leaf and cane spot disease. Controls are the same for both these fungal diseases. Keep plantings well-pruned to promote good air circulation. Remove and destroy infected canes right after harvest. Early in the season, spray with lime-sulfur. Cultivars resistant to both diseases include 'Black Satin', 'Dirksen Thornless', and 'Gem'.

Leaf undersides with bright orange pustules appearing in spring. Cause: Orange rust. This incurable fungal disease infects the entire plant and can't be controlled by spraying. Plants become weak and unfruitful. Diseased plants never recover; infection spreads quickly to neighboring plants. Dig and destroy plants as soon as you notice disease symptoms. Avoid sites near wild blackberries, which may carry the disease. Late in the season, a benign leaf rust appears on some blackberries; disregard it. The cultivars 'Cheyenne', 'Comanche', 'Eldorado', 'Evergreen', and 'Shawnee' are resistant to orange rust.

Canes dying. Cause: Borers. For information identifying and controlling borers, see "Canes dying, break off easily" and "Cane tips wilted and dying" on page 199.

Canes turn yellow and die in midsummer. Cause: Verticillium wilt. This is a common soilborne fungal disease. Typically, leaves yellow, wilt, and fall before the entire cane dies. Avoid planting blackberries following other Verticillium-susceptible crops, such as strawberries, potatoes, tomatoes, and eggplants. Soil solarization may prevent the disease. Verticillium-resistant cultivars include 'Evergreen', 'Logan', 'Marion', and 'Olallie'. See page 197 for an illustration of this disease on raspberries.

Canes with wartlike or corky swellings; canes dying. Cause: Crown gall. Crown gall bacteria live in the soil and enter plants through wounds. For information and controls, see "Canes with wartlike or corky swellings; canes dying" on page 199.

Blueberry

Vaccinium spp. (Ericaceae)

Blueberries are deciduous shrubs ranging in height from 1′ for lowbush blueberries (*Vaccinium angustifolium*) to 6′ for highbush blueberries (*V. corymbosum*) to over 30′ for rabbiteye blueberries (*V. ashei*). The flowers look like dainty white bells and appear in spring on shoots that grew the previous season. Blueberries are hardy in Zones 3-9, depending on species and cultivar.

Culture

Blueberries require full sun and well-drained, moisture-retentive, acidic soil with a pH of 4.0-5.0. Of the 3 species, highbush blueberries are the most finicky about soil. Blueberries generally grow well in soil enriched with acidic organic material, such as peat moss, composted pine needles or oak leaves, or compost made from pine, oak, or hemlock bark. Fertilize with acidic fertilizers, such as cottonseed meal or soybean meal. Blueberries enjoy a thick, organic mulch.

Most blueberries are not wholly self-pollinating. Plant at least 2 different cultivars near each other for adequate cross-pollination.

Prune plants each winter, beginning when bushes are about 4 years old. On highbush and rabbiteye plants, remove drooping or very old branches and thin out branches where growth is too dense. Cut lowbush plants to the ground every third year for a harvest every 2 out of 3 years.

Flower and Fruit Problems

Berries soft and mushy. Cause: Blueberry maggots. If you find ⅜", white maggots inside berries, you've discovered the larvae of the blueberry maggot fly. This insect, closely related to the apple maggot fly, deposits eggs just under the skin of the fruit from late June to August. Eggs hatch into fruit-devouring maggots that later drop to the soil and pupate over the winter. To reduce the number of maggots that pupate in the soil through the next winter, harvest frequently and destroy any infested berries you find. Another control is to trap adult flies on sticky red spheres like the ones used to trap apple maggot flies. Hang 1 trap per highbush plant or 1 per several lowbush plants before the first berries turn blue. For information on making these maggot fly traps, see "Fruit dimpled; brown tunnels through flesh" on page 22.

Berries shriveled and webbed together with silk. Causes: Cherry fruitworms; cranberry fruitworms. Berries will contain sawdustlike material and either a white caterpillar (cherry fruitworm) or a yellowish green caterpillar (cranberry fruitworm). These are the larvae of 2 different moth species that lay eggs on berries in the spring. Larvae hatching from these eggs bore into berries near the stem end and web berries together as they feed. You cannot spray anything to kill worms inside the fruit. To reduce damage from these pests without sprays, harvest berries frequently and destroy infested fruit to prevent larvae from maturing. Regularly cleaning up dropped and damaged berries will do as much as anything to keep fruitworms under control.

Berries drop early; mature berries turn gray, shriveled, and hard. Cause: Mummy berry. This fungal disease overwinters on dried, diseased berries called mummies and spreads most rapidly in cold, wet springs. Control mummy berry by picking all mummies off the plant. In the spring cultivate around bushes to bury dropped mummies, or add mulch to cover the remaining fungal spores. Resistant cultivars include 'Bluetta', 'Burlington', 'Collins',

'Darrow', 'Dixie', 'Jersey', and 'Rubel'.

Blossoms covered with brown splotches or brownish gray mold. Cause: Botrytis blight. This fungal disease spreads most rapidly when cool, wet weather extends throughout the bloom period. An effective control for Botrytis is to carry a paper bag into the garden and carefully pick off and discard blighted blossoms and foliage as soon as you find them. After working around infected plants, wash your hands thoroughly before working with healthy plants. Also space and prune plants to encourage good air circulation and rapid drying of plants after rain. Avoid wetting the foliage when watering and avoid excess fertilization, which brings on lush growth and increased susceptibility to this blight.

Fruit disappears. Cause: Birds. These creatures love blueberries so much that unprotected bushes are often stripped clean of berries, even before they are fully ripe! The only sure protection is a net draped over the planting and held to the ground to prevent birds from getting underneath.

Leaf and Branch Problems

New leaves with black centers; growing tips wilted. Cause: Mummy berry. This fungal disease spreads most easily in cold, wet spring weather. For more information, see "Berries drop early; mature berries turn gray, shriveled, and hard" on page 45.

Leaves or twigs covered with brownish gray mold. Cause: Botrytis blight. An effective control for this fungal disease is to remove and discard blighted foliage as soon as you see it. For more information, see "Blossoms covered with brown splotches or brownish gray mold" above.

New leaves yellow with green veins. Cause: Iron deficiency. The soil usually has sufficient iron but is not acidic enough to make iron available to the plant. Spray leaves with iron salts or chelates for quick relief of symptoms. A long-term solution is to reduce the soil pH by mulching with an acidic material, such as pine needles.

Cane dieback. Causes: Blueberry cane canker; Fusicoccum canker. Blueberry cane canker, most prevalent in the South, shows up as reddish, conical stem swellings. The next year these swellings become blisterlike, light gray, and then black and fissured. If this disease is a problem in your area, plant rabbiteye blueberries, which are not susceptible to cane canker. Or plant highbush cultivars resistant to cane canker, including 'Atlantic' and 'Jersey'.

Fusicoccum canker, a fungal disease more common in colder regions, begins as red stem spots that enlarge and develop a bull's-eye pattern. Resistant cultivars include 'Berkeley', 'Blueray', 'Burlington', 'Coville', and 'Rubel'. Other blights also cause cane dieback, and the best course for all such problems is to prune away diseased branches as soon as you spot them. To avoid spreading disease further as you prune, sterilize pruning tools between cuts in isopropyl alcohol or a 10 percent bleach solution (1 part bleach to 9 parts water).

Leaves skeletonized. Cause: Japanese beetles. Beginning in early summer, these metallic blue-green beetles with bronze wing covers like to feed on plants in the sun. The simplest control is to check plants early in the morning while beetles are sluggish and knock them off leaves into jars of soapy water. Traps baited with floral or fruit scents plus pheromones may be effective if placed at some distance from plants, but some gardeners find that a trap placed in the middle of a planting attracts more beetles than normal to the garden. If you use traps, be sure to place them well away from the plantings you're trying to protect.

Populations of this pest naturally decline by midsummer, but for very heavy infestations, spray with neem. Milky disease spores, avail-

able commercially and applied to lawns to kill Japanese beetle grubs, may not work very well to control this pest. Not all the grubs in your yard will become infected with the disease, and beetles that emerge from neighboring properties may fly to your plants. You can also buy parasitic nematodes to apply to the soil for control of Japanese beetle grubs.

Broccoli

Brassica oleracea
Botrytis group (Cruciferae)

Broccoli is a cool-season vegetable grown for its crisp green heads of flower buds. Broccoli and cabbage require similar culture and are attacked by the same diseases and insects: See the Cabbage entry beginning on page 52 for culture and information on problems.

Prevent problems by planting the following improved cultivars: 'Green Dwarf #36', 'Emperor', and 'Mariner' are black rot-tolerant; 'Premium Crop' is resistant to Fusarium yellows; 'Citation', 'Emperor', 'Esquire', 'Green Dwarf #36', 'Hi-Caliber', and 'Mariner' are tolerant of downy mildew; and 'De Cicco' is tolerant of flea beetles.

In addition to the problems listed below, transplants exposed to cool temperatures (35°-45°F) for 10 days or more may form tiny, useless flower heads prematurely. High temperatures can cause similar tiny head formation. Broccoli grows best at temperatures between 45°-75°F. Harvest heads when buds are still tight and dark green or dusky violet, except for 'Romanesco', which should be yellow-green.

Problems

Heads small and uneven; stems hollow. Cause: Potassium deficiency. Prevent problems by spraying plants with seaweed extract every 2 weeks. Check soil potassium with a soil test and amend as necessary.

Heads with black or discolored centers. Causes: Fungal rot; cold injury. Broccoli heads rot when water collects between the individual flower buds. Avoid wetting heads when watering. Cold weather can also cause black areas in the center of heads. Protect plants with row cover when temperatures below 40°F are predicted.

Browallia

Browallia, sapphire flower. Annuals.

Browallias bear profuse quantities of purple or blue, 1″-2″ flowers. They grow in bush form, 10″-18″ high, or will cascade over container edges. They bloom in summer and into fall. Browallias do well as bedding plants, hanging baskets, or houseplants.

Browallias grow easily from seed. Sow indoors in March. Do not cover seed; they need light to germinate. Seedlings appear in 2 weeks. Pinch when 6″ tall for bushier plants. Transplant when night temperatures remain consistently above 50°F; space 10″ apart.

Browallias need partial shade and moderately rich soil. Keep the soil evenly moist. Fertilize lightly but regularly. Pests and diseases seldom bother browallias. Whiteflies sometimes feed on plants; see "Leaves yellow; plant weakened" on page 18.

Brussels Sprouts

Brassica oleracea
Gemmifera group (Cruciferae)

Brussels sprouts are a cool-season vegetable grown for their small, cabbage-shaped buds. They are one of the hardiest members of the cabbage family and can tolerate lower pH (5.5-6.8) than any of the other brassicas. But, they are less tolerant of heat. In warmer climates grow sprouts in soil with a high clay content if you have a choice, and shade the soil around roots. Harvest sprouts when they are 1″ in diameter or smaller and still tight. Twist them off gently, starting at the base.

Brussels sprouts and cabbage require similar culture and are attacked by the same diseases and insects: See the Cabbage entry beginning on page 52 for culture and information on problems.

In addition to problems outlined in the cabbage entry, a combination of cold injury and viral disease can cause leaves with black specks. Destroy infected plants. Caterpillars will bore small holes into sprouts; see "Leaves with large, ragged holes" on page 56 for more details and controls. Plants deficient in potassium have poorly developed sprouts: Spray with seaweed extract at transplanting and repeat several times to prevent problems. Check potassium levels with a soil test, and amend as necessary.

Buddleia

Butterfly bush. Shrubs.

Butterfly bush (*Buddleia davidii*) is a deciduous shrub producing long spikes of bloom in midsummer. In severe climates it tends to die back to the roots over winter; where this does not occur, cut plants back to near ground level to promote healthy growth and flowering.

Buddleias thrive in rich, loamy soil in full sun. They are remarkably free of insect and disease problems. Japanese beetles have been known to attack them, but rarely severely. Handpicking or inoculating your lawn with milky disease spores will usually suffice; stronger control methods can endanger the butterflies that these plants attract.

Bulbs

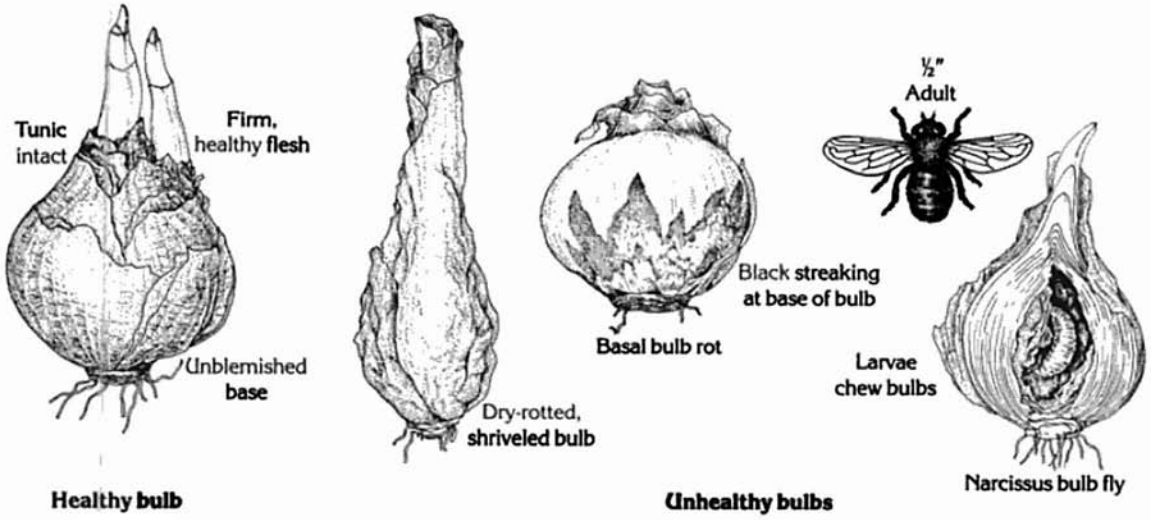
The term *bulb* is used to describe a variety of underground storage organs, including corms, rhizomes, and tuberous roots. Some are modified stems, while others are simply enlarged roots. Although structurally different, bulbs all store food for plant growth in subsequent seasons and spread (in the case of rhizomes) or otherwise multiply asexually to increase a plant's population.

Whether they are hardy corms, such as crocuses, that bloom year after year in the same spot, or tender rhizomes, such as cannas, that must be dug up and stored over winter, bulbs generally enjoy similar growing environments and suffer similar problems. Pest and disease prevention is preferable to applying controls after trouble arises. The following bulb-buyer's guidelines will help you avoid most bulb problems.

■ Buy only dormant bulbs that show little, if any, root development and no topgrowth other than a pale, fat bud. (Lilies, however, are never completely dormant; their bulbs often have fleshy roots attached.)

■ Purchase and plant bulbs at the right time. Reputable dealers sell bulbs in defined

BUYING HEALTHY BULBS



Choosing bulbs carefully is an important step toward a beautiful and care-free flower garden. Select bulbs, such as the healthy daffodil pictured, that seem heavy for their size and that are free of cuts, bruises, and discoloration. Be wary of lightweight or shriveled bulbs.

seasons: fall for spring-flowering bulbs (daffodils, tulips), spring for summer-flowering bulbs (lilies, glads), and summer for fall-flowering species (some crocuses).

■ Look for bulbs that have their papery skins—called tunics—intact. These contain natural compounds that inhibit disease and premature sprouting.

■ Choose bulbs packaged in materials that permit air to enter. Damp bulbs in plastic bags often rot.

■ Select bulbs that are firm with few wrinkles and no soft spots. Healthy bulbs seem somewhat heavier than their size suggests. Avoid unusually lightweight bulbs and those with cuts, dark or water-soaked spots, or discolored or scabby areas.

Growing healthy, trouble-free bulbs also depends on good cultural practices. Fleshy bulbs are prone to bacterial and fungal rot organisms, most of which thrive in wet conditions. Prepare bulb planting beds well and make sure the soil is well-drained. Handle bulbs carefully when planting to avoid injuries that provide access to diseases. Remove problem plants quickly to keep pests and diseases from spreading. Always let bulb foliage die back naturally to allow food production for growth and flowering in subsequent years. Mark sites where bulbs are planted so you can find them after foliage has faded. Clean up flower beds in fall to remove plant debris that offers shelter to many pests and diseases.

Healthy bulbs and good culture go a long way toward successful plantings. A few pests

and diseases, however, are prevalent among bulbous plants; controls for these problems do not vary significantly among species.

Problems

Leaves yellow or distorted; bulbs decayed. Cause: Bulb mites. These 1/50"-1/25", whitish mites feed in groups on bulbs. Infested bulbs have corky, brown spots that become powdery. Bulb mites are attracted to damaged or rotting bulbs, but can move to healthy ones, carrying rot-producing fungi and bacteria as they travel. When buying bulbs, inspect them carefully for damage or signs of infestation; for more information, see the illustration on page 49. Dip bulbs in hot (120°F) water for a few minutes to kill mites. Dig and destroy severely infested bulbs; solarize the soil before planting in previously infested ground.

Leaves and/or flowers with holes. Causes: Japanese beetles; other leaf-eating beetles. A number of hungry beetles, including 3/4" long black blister beetles, 1/4" long spotted cucumber beetles, 1/3" long, reddish brown rose chafers, and nocturnal, 1/3" long, gray Fuller rose beetles feed on the leaves and sometimes the blossoms of flowering bulbs. Iridescent green-and-bronze, 1/2" Japanese beetles top this list of troublesome pests; the adults devour the leaves, stalks, and flowers of nearly 300 plant species, while the 3/4", C-shaped grub larvae feed on roots and are a major pest of turf grasses.

Injury caused by adult beetles ranges from small holes in leaves to skeletonized foliage to complete defoliation; feeding by weevils, such as long-nosed Fuller rose beetles, resembles "ticket punches" around leaf margins. Japanese and spotted cucumber beetles are fond of flowers and often do most of their damage there. Most beetles are active during the day and are large enough to be readily visible while they feed. Weevils more often prefer nighttime feeding.

Handpick adult beetles into a bucket of soapy water or a 5 percent solution of isopropyl alcohol. Wear gloves if your pests are blister beetles; contact with crushed beetles causes burns and blisters on skin. Shake infested plants in early morning to knock beetles onto a dropcloth, then scoop them up and destroy. Pheromone traps are available for Japanese beetles, but they are most helpful if you can convince your neighbors to use them, too; otherwise, your traps may just attract beetles from their yard into yours. Apply milky disease spores to your lawn for long-term larval control. Apply parasitic nematodes to soil to limit all beetle grub populations. As a last resort, spray affected plants with neem or pyrethrin.

Leaves with large, ragged holes. Cause: Slugs and snails. Differing only in the presence or absence of a shell, slugs and snails range in size from 1/8" to 8" and may be gray, tan, green, black, yellow, or spotted. Broad foliage, arising at or near the soil surface, makes many flowering bulbs appealing to these busy mollusks. Mulch provides shady hiding places from which they emerge to feed nocturnally. All species rasp large holes in leaves, stems, and bulbs; slimy trails of mucus also signal their presence.

Since slugs and snails travel over the ground on a flat, muscular foot, you can impede their progress with barriers of materials that irritate their soft bodies. Sprinkle bands of coarse, dry, scratchy materials such as cinders, wood ashes, cedar sawdust, and diatomaceous earth around plants or beds; renew frequently. Push 4"-8" copper strips into the soil around beds as edging. Lay boards, cabbage leaves, or overturned clay pots—anything that offers a cool, damp daytime haven—around the garden; destroy pests that congregate underneath. Handpick slugs and snails from plants at night; drop them into soapy water or sprinkle them with table salt to dehydrate and kill them. Set shallow pans into the soil, placing the lip flush with the soil surface and fill with stale beer or

any fermenting liquid; remove drowned pests daily. Encourage predatory ground beetles by maintaining clover, sod, or stone walkways.

Leaves, stems, and buds distorted, sticky; clusters of small insects. Cause: Aphids. Several species of pear-shaped, 1/32"-1/8" aphids attack flowering bulbs. Aphids can be green, pink, black, gray, or with a white fluffy coating and have long antennae and 2 short tubes projecting from the rear of their abdomens. These pests gather under leaves and on growing tips. Some, such as tulip bulb aphids, also infest bulbs, clustering beneath the tunic. Aphids suck plant sap, causing leaf and bud distortion and blossom and leaf drop. Their feeding may spread viral diseases. As they feed, they excrete sticky honeydew on which sooty molds grow; see "Leaves with black coating" below for more information.

Wash aphids from plants with a strong spray of water; repeat as needed to control infestations. Encourage natural predators and parasites such as aphid midges, assassin bugs, lacewings, lady beetles, and spiders. If water sprays fail, apply homemade garlic or tomato-leaf sprays, or try sprays of alcohol, citrus oil, insecticidal soap, or neem. Use boric acid baits to control ants that herd aphids onto plants. As a last resort, spray or dust aphids with pyrethrin.

Leaves with black coating. Cause: Sooty mold. This fungus grows on the sugary, sticky honeydew produced by aphids and other sucking pests such as scales, whiteflies, and mealybugs. The black fungal coating doesn't harm leaves directly, but it does shade the leaves and reduce growth. The best control is to deal with the pests that are producing the honeydew. Identify the pest and apply the appropriate control. (If the plant itself doesn't show signs of pest damage, the honeydew may be dripping down from an overhanging plant.) On small plants, wipe the leaves with a damp cloth to remove the honeydew and the sooty mold.

Buxus

Boxwood. Shrubs.

Boxwoods are evergreen shrubs with glossy, opposite leaves. They are widely used for hedges.

Boxwoods prefer a site partially sheltered from winter winds. They will flourish in a range of conditions, from full sun to deep shade, and can adapt to almost any soil (with the exception of poorly drained sites or heavy clays). Set out as balled-and-burlapped or container-grown plants in spring. Set out plants no deeper than they grew in the nursery. A thick layer of mulch will help keep roots cool and retain moisture. Clean up all fallen leaves and remove debris from branch crotches in autumn.

Problems

Leaves blistered and browned. Cause: Boxwood leafminers. The 1/8", orange larvae tunnel and feed within leaves. After they feed, the maggots change to the adult form and emerge as 1/8", orange, mosquito-like flies. Use yellow sticky traps to monitor the emergence of adults. When they begin to appear (usually late April and early May), spray plants with superior oil.

Leaves curled and cupped around stem tips. Cause: Boxwood psyllids. The eggs and larvae of this tiny green insect overwinter on buds and infest new leaves in spring. Spray plants with insecticidal soap, or pyrethrin for serious infestations, at the first sign of damage.

Leaves stippled with yellow; foliage webbed. Cause: Spider mites. See "Leaves stippled with yellow; foliage webbed" on page 236 for controls.

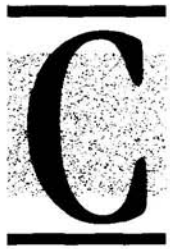
Leaves brown; twigs die back. Cause: Winter damage. Cold, dry winter winds can seriously injure tender growth. Avoid damage by spraying leaves with an antidesiccant in

fall, or provide shelter for plants with burlap windbreaks. Mulch heavily in fall, and water well before the ground freezes. Fertilize plants in early spring only; summer feeding promotes easily damaged, late-season growth. Prune out affected parts.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. See "Leaves yellow; stems and leaves covered with small bumps" on page 237 for control suggestions.

Leaves yellow, sparse, distorted, or with brown edges; branches die; growth stunted. Cause: Decline. For more information, see "Leaves yellow, sparse, distorted, or with brown edges; branches die; growth stunted" on page 238.

Whole plant stunted and lacking vigor. Cause: Nematodes. See "Whole plant stunted and lacking vigor" on page 239 for controls.



Cabbage

Brassica oleracea
Capitata group (Cruciferae)

Cabbage is a cool-season vegetable grown for its crisp, dense leaf heads. There are green and purple cultivars and ones with savoyed, or crinkled, leaves.

Culture

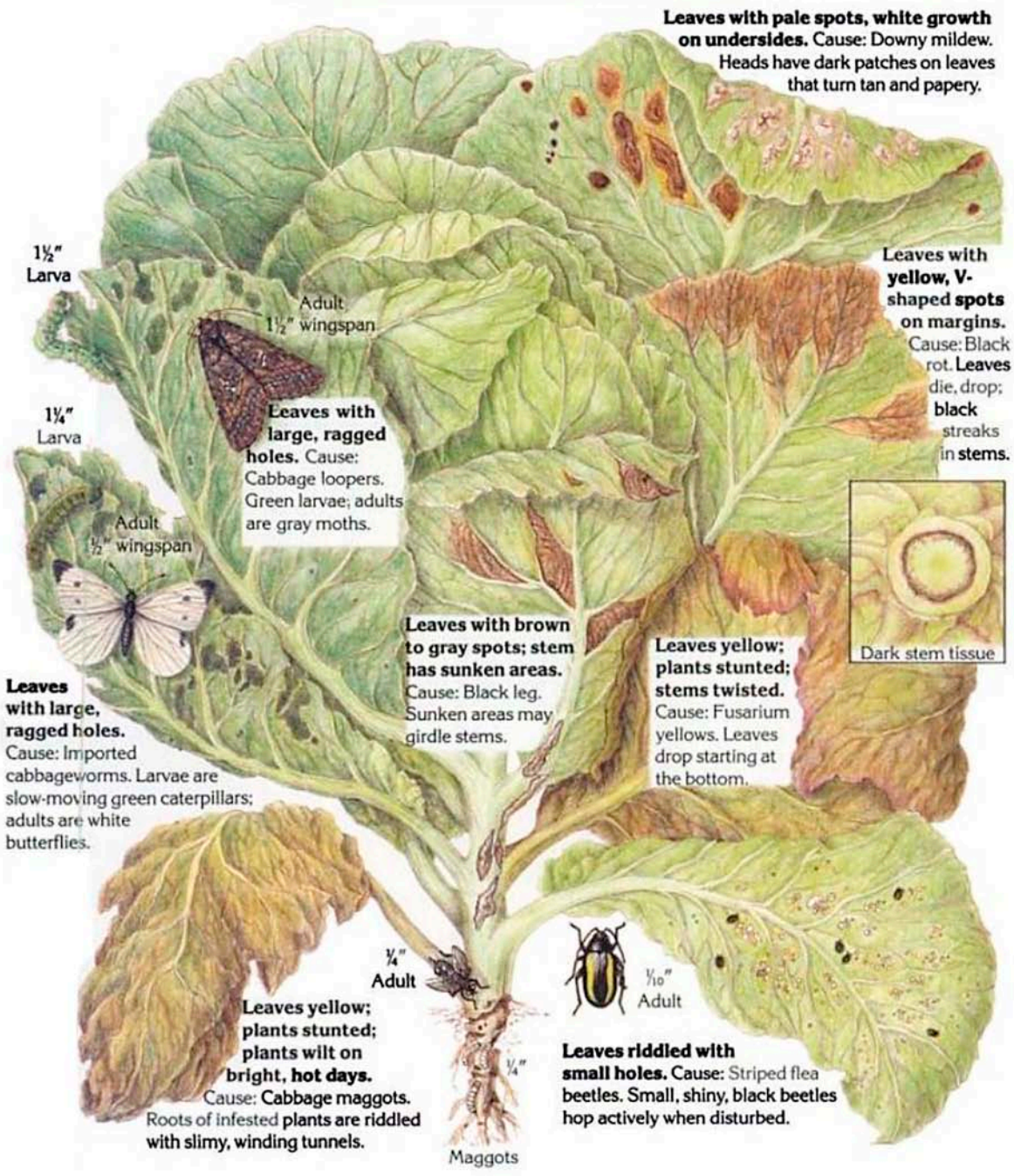
Plant cabbages in full sun in a site with fertile, well-drained soil and a pH between 6.0 and 6.8. If you have a choice of sites, spring plantings do best in lighter, sandier soils, while fall plantings do better in soils that contain more clay. Plants grow best at temperatures between 40° and 75°F.

Cabbages are biennial, and transplants exposed to cool temperatures (35°-45°F) for 10 or more days may bolt or go to flower prematurely. High temperatures also cause bolting.

These plants have very shallow roots, so be sure to keep the top few inches of soil from drying out. Fluctuations in soil moisture after the heads have formed may cause them to split. Mulching helps to balance and conserve moisture. Most cabbage diseases need free water to spread, so don't water with overhead sprinklers.

To avoid problems, don't plant cabbages where members of the cabbage family (broccoli, cauliflower, brussels sprouts, or kale) have grown for at least 3 years. Also, avoid areas

CABBAGE ◆ What Goes Wrong and Why


Leaves with pale spots, white growth on undersides. Cause: Downy mildew. Heads have dark patches on leaves that turn tan and papery.
1½" Larva
Adult 1½" wingspan
Leaves with large, ragged holes. Cause: Cabbage loopers. Green larvae; adults are gray moths.
Leaves with yellow, V-shaped spots on margins. Cause: Black rot. Leaves die, drop; black streaks in stems.
1¼" Larva
Adult ½" wingspan
Dark stem tissue
Leaves with brown to gray spots; stem has sunken areas. Cause: Black leg. Sunken areas may girdle stems.
Leaves yellow; plants stunted; stems twisted. Cause: Fusarium yellows. Leaves drop starting at the bottom.
Leaves with large, ragged holes. Cause: Imported cabbageworms. Larvae are slow-moving green caterpillars; adults are white butterflies.
¼" Adult
Leaves yellow; plants stunted; plants wilt on bright, hot days. Cause: Cabbage maggots. Roots of infested plants are riddled with slimy, winding tunnels.
¼"
Maggots
1/10" Adult
Leaves riddled with small holes. Cause: Striped flea beetles. Small, shiny, black beetles hop actively when disturbed.

with cabbage family weeds, such as wild mustard. Destroy all crop residues, including roots, after harvest.

If you start your own plants, soak the seed in 122°F water for 25 minutes before planting to eliminate seed-borne diseases. (Be aware that this treatment can damage seed viability; for complete instructions, see page 422.) Once your seeds have germinated, grow seedlings at 60°F to keep them short and stocky.

Cabbages are heavy feeders and are susceptible to several nutrient deficiencies, including boron, calcium, phosphorus, and potassium.

Problems

Stems of transplants shrunken and dark near soil line. Cause: Wirestem. Weak plants may wilt and die as the disease progresses; seedlings that survive yield poorly. Later in the season, the same fungal disease rots the head from the bottom up. Spray plants with copper before symptoms develop if you have had problems in the past.

Leaves of transplants purple. Cause: Phosphorus deficiency. Phosphorus is not readily available in cool spring soils. Spray plants with seaweed extract to correct.

Leaves yellow; plant stunted. Cause: Nitrogen deficiency. When this deficiency develops, older leaves turn yellow first. Spray plants and drench roots with fish emulsion to correct.

Leaves yellow; plant stunted; plant wilts on bright, hot days. Causes: Club root; root knot nematodes; cabbage maggots. If you suspect any of these pests, pull up a plant and examine the roots. Roots that are enlarged and clublike indicate club root, a fungal disease; remove and destroy diseased plants. Prevent problems by rotating crops and improving drainage. Add lime to raise the pH to 7.2 or above. Cabbage can tolerate this pH, but club root fungi are less active.

Cabbage roots covered with irregularly shaped galls are infested with root knot nematodes. Destroy severely infested plants. Reduce the number of nematodes in the soil by solarizing soil, keeping area clear of crops and weeds for a summer, or by planting a winter cover crop of wheat. Applying parasitic nematodes or chitin to the soil can also help control pest nematodes.

Cabbage roots riddled with slimy, winding tunnels are infested with cabbage maggots. Larvae are white, ¼" maggots that feed on roots and transmit bacterial and fungal diseases. Adults look somewhat like houseflies and lay eggs on the soil near the base of the plant. See page 53 for an illustration of this pest. Remove and destroy infested plants. Frequent, light cultivation when plants are young helps to decrease larval populations. Or plant each transplant through an X-shaped slit in the center of a 6"-8" square of tar paper to prevent the adults from laying eggs near the stems. Solarizing the soil will help reduce maggot populations in problem areas.

Leaves yellow; plant stunted; stems twisted. Cause: Fusarium yellows. Leaves of afflicted plants drop off starting at the bottom and working up, often leaving a bare stem. Cut stems reveal darkened vascular tissue in afflicted areas. This fungal disease usually occurs soon after transplanting. See page 53 for an illustration of this disease. Destroy infected plants. Use at least a 5-year rotation to prevent problems or plant resistant cultivars such as 'Applause', 'Bravo', 'Early Jersey Wakefield', 'Gourmet', 'Grand Slam Hybrid', 'Green Cup', 'Market Prize', 'Market Victor', 'Ranger', 'Red Danish', and 'Stonehead'.

Leaves curled and yellow; plant stunted. Cause: Aphids. Look for small, green, pink, gray, black, or white fluffy-coated, soft-bodied insects feeding on plants. Aphids can also transmit viral diseases. Control by knocking the pests off the plant with a blast of water, or use an insecticidal soap spray. Severe infestations can be controlled by spraying with neem or pyrethrin.

Leaves with yellow, V-shaped spots on margins. Cause: Black rot. As this bacterial disease progresses, yellow areas on the leaves enlarge and veins turn black. Infected leaves die and drop off. Stems have internal black streaks. Heads are dwarfed and often 1-sided. See page 53 for an illustration of this disease. Destroy infected plants. Spray copper if weather is wet and if you have had problems in the past. Resistant cultivars include 'A & C #5', 'Blue Boy', 'Bravo', 'Fortuna', 'Grand Slam Hybrid', and 'Guardian'.

Leaves with yellow-brown, concentrically ringed spots. Cause: Alternaria blight. This fungal disease attacks lower leaves first. Spots merge and leaves die as the disease progresses. Plants eventually die. Spray plants with copper at the first sign of symptoms. Plant tolerant cultivars such as 'Hybrid H' to prevent problems.

Leaves with white and yellow blotches. Cause: Harlequin bugs. Leaves turn brown, wilt, and die in severe infestations. Look for flat, ½" long, shield-shaped stink bugs with red and black, spotted markings. Nymphs look like adults but are smaller and more round. Handpick to control mild infestations, or spray with pyrethrin. Destroy crop residues after harvest to eliminate pests.

Leaves with pale spots, white growth on undersides. Cause: Downy mildew. Infected heads have dark patches on leaves. As the disease progresses, infected areas enlarge and turn tan and papery. See page 53 for an illustration of this fungal disease. Control by spraying plants with a baking-soda-and-soap spray (1 teaspoon baking soda, 1 teaspoon liquid dish soap, 1 quart water) or copper. The cultivar 'Hybrid H' is tolerant of downy mildew.

Leaves with white-bronze spots. Cause: Thrips. Severe infestations cause leaves to wilt. These tiny insects look like grains of pepper. Trap with sticky blue traps or spray insecticidal soap, making sure to cover undersides of leaves where thrips feed.

Leaves with brown to gray spots; stem has sunken areas. Cause: Black leg. Leaf spots are speckled with tiny black dots. As the sunken areas on stem enlarge, they may girdle the plant and cause it to wilt and die. Dead leaves remain attached to the plant. See page 53 for an illustration of this disease. Spray plants, especially the stems, with copper at the first sign of this fungal disease. When spraying stems, try to avoid spraying copper on the soil, because it is toxic to many soil organisms, including earthworms. Prevent black leg by using a 4-year rotation and improving soil drainage.

Leaves with brown tips. Causes: Excessive heat; calcium deficiency. Browning of the tips of outer leaves is caused by extreme heat. Cabbage is sensitive to bright sun and temperatures above 80°F. Plant cultivars that resist tipburn such as 'Hancock Hybrid' and 'Multikeeper'.

Brown leaf tips inside the head are caused by calcium deficiency. Many factors contribute to poor calcium uptake. To prevent problems, keep soil moisture constant and side-dress plants with compost to provide balanced nutrition.

Leaves cracked and corky; stem water-soaked or hollow inside the head. Cause: Boron deficiency. Plants in the cabbage family need lots of boron. Spray plants with seaweed extract when transplanting and repeat several times until head formation to help prevent problems. Raise the boron level of the soil by adding 1 tablespoon of borax dissolved in 1 gallon water, or 10 pounds of kelp, per 100 square feet.

Leaves riddled with small holes. Cause: Striped flea beetles. These small, shiny, black beetles hop when disturbed. They can transmit viral and bacterial diseases. See page 53 for an illustration of this pest. Protect young plants with row cover until they have at least 6 leaves. 'Early Jersey Wakefield' tolerates beetle damage better than most cultivars.

Leaves with large, ragged holes. Cause: Caterpillars. Look for dark green excrement

at the base of leaves or plant. Imported cabbageworm is a velvety green, slow-moving caterpillar up to 1¼" long. Adults are small white butterflies. Cabbage loopers are light green, 1½" long caterpillars with a white stripe along each side. They travel with a characteristic "looping" movement, like an inchworm. Adults are gray moths. See page 53 for an illustration of these 2 pests. Diamondback moth caterpillars are pale green with light brown heads, 5/16" long, pointed at both ends, and covered with fine black hairs. Adults are slender, ½" long moths.

Apply a BTK spray as soon as active caterpillars or feeding are observed; remember to look inside heads for early signs of feeding. Pheromone traps are available for male cabbage looper moths; spray with BTK 1-2 weeks after the first moths are caught in the traps. Help reduce problems by planting cultivars, such as 'Danish Ballhead', 'Early Jersey Wakefield', and 'Red Ace', that are less susceptible to cabbage looper and imported cabbageworm feeding.

These caterpillars are all parasitized by wasps, and other beneficials feed on both eggs and larvae. A native virus may also kill caterpillars later in the season. Infected caterpillars move slowly, become yellow, and die. Let nature work for you and avoid handpicking or spraying if caterpillars are infected or covered with the small, white, spindle-shaped eggs of parasitic wasps.

Heads small and soft; color poor in red cabbage. Cause: Potassium deficiency. Check with a soil test and amend as needed.

Heads split. Cause: Excessive water. Keep soil constantly moist, but not saturated, especially when heads are forming.

Heads rot. Cause: Fungal diseases. A variety of fungi cause cabbage heads to rot. Destroy rotted plants. Spray plants with copper before symptoms develop if you have had problems in the past.

Calendula

Calendula, pot marigold. Annuals.

Calendulas are herbs that have 1"-3", orange or yellow flowers, giving bouquets of color for borders and indoor use. Plants grow 1'-3' high with a bushy habit. Calendulas blend well into bedding schemes, herb gardens, and containers.

Sow seeds indoors 4-6 weeks before transplanting outdoors into warm spring soil. Direct-seed in early summer for color in late summer or fall. Plant seeds ¼" deep; they need darkness to germinate. They should sprout in 1 week. Thin seedlings to 1'.

For earliest color, transplant or seed in full sun. In hot climates plants appreciate some afternoon shade. While calendulas tolerate poor soil, they prefer average soil and must have good drainage. Water regularly, keeping soil slightly moist. When first buds appear, pinch back the main stem to promote maximum flowering. In adverse conditions, such as excess heat, calendulas may still flower, but stems will be shorter.

Problems

Leaves, stems, and buds distorted. Cause: Aphids. For controls, see "Leaves, stems, and buds distorted" on page 20.

Leaves with large, ragged holes. Causes: Imported cabbageworms; slugs and snails. Cabbageworms are green caterpillars with a yellow back stripe and yellow side spots. Handpick cabbageworms or spray leaves with BTK when pests first appear.

Slugs and snails cause similar damage, and leave behind slimy trails of mucus. For controls, see "Leaves with large, ragged holes" on page 18.

Leaves greenish yellow; growth poor.

Cause: Aster yellows. For more information, see "Leaves greenish yellow; growth poor" on page 19.

Callistephus

China aster. Annuals.

Not true asters, China asters provide showy, single or double, daisylike blossoms from midsummer until autumn with successive plantings. There are early, mid-season, and late-flowering cultivars. A range of color choices is available, including blue, purple, pink, red, rose, yellow, or white. Individual flowers can reach 5″ wide; petal types are quilled, spooned, or curled. Plant size varies from 9″ to 24″ high, with a possible 1½′ spread. Low-growing cultivars make good edging plants. Taller cultivars are popular for long-lasting cut flowers. Plants will not rebloom once flowers have been cut.

Direct-sow outdoors a week or two after the last frost, barely covering the seed. Seeds germinate within 2 weeks. Or, for earlier flowers, sow seeds indoors 6-8 weeks before the last frost. Move seedlings to individual 3″ pots when the first true leaves appear. Move plants outdoors when nights are consistently above 50°F. Handle carefully during transplanting to avoid damaging the roots. Space 6″-15″ apart. Each plant blooms for about 4 weeks. Successive plantings 2 weeks apart are the key to a long display season.

China asters tolerate light shade only. They thrive in fertile, moist but well-drained soil in full sun. China asters are shallow-rooted, so cover soil with a 1″ mulch to retain soil moisture and keep roots cool. Pinch growing tips to promote bushiness. Water regularly so soil stays slightly moist. Uneven care that slows growth makes the plant susceptible to disease. Remove old flowers. Tall cultivars may need staking to support heavy flowers on the slim stems.

Problems

Leaves greenish yellow; growth poor. Cause: Aster yellows. For more information, see "Leaves greenish yellow; growth poor" on page 19.

Lower leaves yellow, wilt, and die. Cause: Fusarium wilt. Other symptoms of this common fungal disease include yellowing and wilting of 1 side of plant only; drooping flower heads; stunted mature plants; dark brown areas on stems; and partial or total root decay. Once introduced on diseased plants or transmitted by wind, water, or handling, Fusarium wilt lives on indefinitely in soil. There is no cure. Remove infected plants and dispose of them in sealed containers in household trash. Never plant China asters in the same location 2 years in a row. Wilt-resistant cultivars are available, but they are not completely immune.

Leaves, stems, and buds distorted. Cause: Aphids. For control measures, see "Leaves, stems, and buds distorted" on page 20.

Camellia

Camellia. Shrubs and small trees.

Camellias are evergreen shrubs or small trees that bear spectacular flowers. They are popular as foundation plants or hedges in areas where they are hardy. In cold climates grow these plants in a cool greenhouse.

Camellias require a moist, peaty, acidic soil well-enriched with organic matter. Set out as bare-root plants in partial shade. A thick

Copyrighted material

layer of mulch will protect the shallow roots and help retain soil moisture.

Problems

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. See "Leaves yellow; stems and leaves covered with small bumps" on page 237 for control suggestions.

Flowers turn brown and fall off. Cause: Flower blight. This soilborne fungus causes small brown spots that expand to cover entire petals. Prevent problems by setting out only bare-root plants and picking off all blooms as they fade. If the disease does strike, remove and destroy all the flowers. Use a preventive spray of bordeaux mix in the spring. Surround plants with a 3" layer of mulch to keep spores from splashing up from the soil to the flowers.

Leaves with notched edges. Cause: Fuller rose beetles. The adult is a 1/3", grayish brown beetle with a cream-colored stripe on each side of its body. It feeds at night on foliage. The yellowish, brown-headed larvae feed on plant roots. Handpick adults as they hide in foliage during the day. Place sticky barriers, such as Tanglefoot, around the base of plants to keep adults from climbing up to the leaves. Drench soil around the plant with a solution of parasitic nematodes to control larvae.

Campanula

Bellflower, harebell. Perennials.

The profuse dainty, blue, purple, or white, bell-shaped flowers of *Campanula* spp. brighten gardens from spring through summer. This large genus includes annual, biennial, and perennial species that range in size from low-growing Carpathian harebells (*C. carpatica*) to 2'-3' tall, peach-leaved bellflowers (*C. persicifolia*).

Mountain natives, bellflowers prefer full sun to light shade; well-drained, organic soil; and regular watering. Serbian bellflower, *C. poscharskyana,* tolerates drought, but most other bellflowers do not. A layer of mulch helps keep the root zone cool and holds in moisture during hot summer weather; a winter mulch protects roots from heaving. Divide plants in spring every 3-4 years.

Problems

Leaves, stems, and buds distorted, sticky; clusters of small insects. Cause: Aphids. See "Leaves, stems, and buds distorted, sticky; clusters of small insects" on page 177 for controls.

Leaves with large, ragged holes. Cause: Slugs and snails. For controls, see "Leaves with large, ragged holes" on page 177.

Leaves and flowers distorted and with brown spots. Cause: Thrips. The same thrips that feed on onions feed on bellflowers. Damage to young plants is most severe. Water stress encourages thrips multiplication and damage. These 1/50"-1/25", yellow, brown, or black pests are difficult to see with the naked eye, but the streaking, spotting, and distortion caused by a heavy thrips infestation is distinctive. Protect plants from thrips damage with predatory mites and blue or yellow sticky traps; in severe cases apply sprays of alcohol, insecticidal soap, neem, or pyrethrin, or dust the undersides of leaves and the surrounding soil with diatomaceous earth.

Leaves yellow and wilting; stems blackened at base; plant topples over. Cause: Stem, root, and crown rots. These problems are common when bellflowers are kept overly wet or are grown in poorly drained soil. The base of an infected plant may show grayish white mold; dark lesions blacken the stem from the soil up, eventually girdling the plant. Remove and

destroy infected plants and surrounding soil. Let soil dry somewhat between waterings, and incorporate organic matter to improve soil drainage. Avoid overwatering and overcrowding; keep winter mulch away from the crowns to prevent excess moisture. Protect crowns from injury, especially when plants are dormant and hard to see. Wash tools after working around infected plants.

Canna

Canna. Rhizomes.

Cannas' large, paddle-shaped leaves and brightly colored red, yellow, orange, pink, white, or variegated flowers add a tropical look to summer and fall gardens. These heat-loving hybrids (*Canna* × *generalis*) grow 1½′-8′ tall with a spread of about 3′.

In Zones 8-10 cannas will survive winter temperatures, but in northern zones, the rhizomes are overwintered indoors. In either case, plant rhizomes 3″-5″ deep and 1′ apart in average, moist but well-drained soil in full sun. Both shade and excess nitrogen fertilizer can reduce bloom. In cold winter areas, start rhizomes indoors in pots as early as February. Move outdoors in spring. If necessary, divide roots at spring planting time. Use a sharp knife, and leave at least 1 good-size bud on an ample piece of rhizome. Let divisions dry overnight before planting. To overwinter, carefully dig up the rhizomes in fall after frost blackens the leaves. Allow them to dry for a few days, then store them in containers of barely moist sand or perlite in a cool place.

Problems

Leaves and/or flowers with holes. Cause: Japanese beetles. See "Leaves and/or flowers with holes" on page 50 for controls.

Leaves with large, ragged holes. Cause: Slugs and snails. For control information, see "Leaves with large, ragged holes" on page 50.

Leaves rolled. Cause: Leafrollers. These pests roll leaves into tubes and fasten them with webbing while feeding. Handpick and destroy rolled leaves; encourage parasitic *Trichogramma* wasps. Sprays of BTK are most effective when pests are young.

Cantaloupe

Cucumis melo
Reticulatus group (Cucurbitaceae)

Cantaloupe is a name commonly used for muskmelons in the United States. See the Melon entry beginning on page 148 for culture and pest information. Harvest when fruit smells ripe and the stem separates easily from the vine.

Carpinus

Hornbeam. Trees.

Hornbeams are bushy, slow-growing, alternate-leaved trees. They are occasionally used as specimen trees, but difficulty in transplanting limits their use.

Set out balled-and-burlapped plants in early spring. Hornbeams are excellent urban trees and, while preferring full sun, will grow satisfactorily in partial shade. They are widely tolerant of various soil types.

Hornbeams are remarkably free of problems. Maple phenacoccus scale may detract from the appearance of the plant, coating the undersides of leaves with fluffy white egg masses. See "Leaves yellow; whole plant weakened" on page 13. Leafminers may also attack; see "Leaves tunneled" on page 237.

Carrot

Daucus carota var. *sativus* (Umbelliferae)

Carrots are a biennial vegetable grown for their crisp, sweet roots. They are a cool-season crop, hardy enough to be undisturbed by light frosts in the spring and fall.

Culture

Carrots grow best in deeply worked, loose soils with a pH between 5.5 and 6.8. No other vegetable is as sensitive to poor soil structure. Misshapen carrots are more often a result of lumpy or compacted soil than any pest problem. Carrots do well in raised beds. Work in a generous amount of compost or well-rotted manure before planting. Cultivars with short roots will tolerate shallow or poor soil better than long, thin cultivars.

Carrots grow best when temperatures are between 60° and 70°F. They grow poorly above 75°F, but will tolerate temperatures as low as 45°F. Most cultivars grow short roots at high temperatures, and longer, more pointed roots at lower temperatures.

Abundant water is necessary for good root development. It is especially important to give emerging seedlings an edge against weeds. Keep soil evenly moist, but not saturated.

To prevent problems with diseases and insects, do not plant carrots where carrots or parsley has grown for 3 years.

Carrots require moderate to high levels of potassium and phosphorus, but only moderate levels of nitrogen, so avoid high-nitrogen fertilizers. Carrots are very sensitive to salt injury and do poorly in soils with high sodium levels.

Leaf Problems

Young leaves yellow and dwarfed; growth bushy. Cause: Aster yellows. Older leaves of plants infected with this disease may be purplish. Once a plant is infected, there is no cure; destroy infected plants. The disease is spread by green or brown, wedge-shaped 1/10"-1/8" long leafhoppers. Cover emerging seedlings with row cover if leafhoppers have been a problem. Control leafhoppers by spraying plants with insecticidal soap in the evening, or for severe infestations, with a commercial neem or pyrethrin spray.

Leaves yellow and curled or distorted. Causes: Aphids; tarnished plant bugs. Aphids are small, soft-bodied, green, black, gray, pink, or white fluffy-coated insects that suck plant sap. For a mild infestation, knock pests off plants with a blast of water. Control them by spraying plants with insecticidal soap or with a commercial neem or pyrethrin spray if infestation is severe.

Tarnished plant bugs are oval, light green to brown, 1/4" long bugs with a lighter triangle on each wing. Nymphs are smaller, yellow-green insects with black spots. Control them with white sticky traps or by spraying or dusting plants with pyrethrin in the evening. Turn crop residues under after harvest to reduce future problems.

Leaves yellow; plant wilts during bright, hot days but recovers at night. Cause: Root knot nematodes. See "Roots misshapen and covered with numerous hairlike roots" below for controls.

Older leaves yellow; plant stunted. Causes: Nitrogen deficiency; waterlogged soil. Spray foliage and drench roots with fish emul-

sion or fish-meal tea to alleviate symptoms. Plant carrots in well-drained soil. Keep soil evenly moist, but not saturated.

Leaves with dark, yellow-bordered spots. Causes: Cercospora leaf blight; Alternaria leaf blight; bacterial leaf blight. For the fungal blights, pick off spotted leaves and spray foliage with fish emulsion to encourage new growth. If disease continues to spread, spray foliage with sulfur. To prevent problems, soak seed in 122°F water for 20 minutes before planting. (Be aware that this treatment can damage seed viability; for complete instructions, see page 422.) Plant cultivars, such as 'Huron', 'Orlando Gold Hybrid', and 'Seminole', that are somewhat resistant to Alternaria.

Bacterial blight also causes dark brown streaks on petioles. Destroy the whole plant. Spray plants with copper if bacterial blight has been a problem in the past. To prevent problems, soak seed in 122°F water for 20 minutes before planting.

Root Problems

Roots forked and misshapen. Cause: Lumpy or compacted soil. Prevent problems by working soil deeply and adding lots of compost. Plant shorter-rooted cultivars in rocky or clay soil.

Roots misshapen and covered with numerous hairlike roots. Causes: Root knot nematodes; aster yellows. Root knot nematodes cause tiny round swellings on side roots. Prevent future root knot nematode problems by applying chitin or parasitic nematodes to the soil before planting.

Roots infected with the disease aster yellows are small, woody, hairy, and taste bitter. See "Young leaves yellow and dwarfed; growth bushy" above for controls.

Roots with green shoulders. Cause: Light exposure. Keep carrots covered with 2" of soil to prevent problems.

Roots with dark tunnels. Causes: Carrot weevils; carrot rust flies; carrot beetles. Carrot weevils usually attack the upper and outer parts of the root. Tunnels are often in a zigzag pattern. Larvae are creamy white, ⅓" long grubs with brown heads. Adults are coppery brown, ⅛" long snout beetles. Destroy infested roots; don't put them in the compost. Control larvae by applying parasitic nematodes to the soil. Control adults, which emerge early in the spring to lay eggs, by covering the seedbed with row cover or by spraying or dusting plants with pyrethrin as soon as you see adult weevils.

Carrot rust fly maggots feed throughout the root, leaving randomly patterned tunnels filled with a rust-colored, sawdustlike material. Larvae are ⅓" long, white maggots. Adults are small flies with yellow heads. Apply parasitic nematodes to soil to control larvae. Prevent problems by planting after June 1st to avoid the first hatching of the season. Cover seedbed with row cover to prevent adults from laying eggs on soil.

Carrot beetle larvae are 1", bluish white grubs that feed on the roots. Adults are ½", reddish brown or black beetles. Fall cultivation reduces overwintering populations; crop rotation will also help.

Roots with small, irregular holes; plant may be stunted and yellow. Cause: Wireworms. Damage usually occurs later in the season and is worse in dry years. Larvae are up to 1½" long, yellow to reddish brown, slender, tough-bodied, segmented grubs with brown heads. Adults are ⅓"–¾" long, dark-colored, elongated click beetles. Control wireworms by applying parasitic nematodes to the soil.

Roots or crowns rotted. Cause: Various fungal or bacterial diseases. Root rot is often brought on by soggy, poorly drained soil or previous insect damage to the roots. Plant carrots in loose, well-drained soil and keep soil moist, but not soggy. Use raised beds to improve drainage.

Roots with internal cavities; may split open. Cause: Cavity spot. This condition is caused

by a combination of factors: calcium deficiency, high levels of potassium, and possibly various diseases. To prevent problems, keep soil moist, but not soggy. Add gypsum, or high-calcium lime if pH is below 6.2, to raise calcium level, and withhold high-potassium fertilizer.

Roots with jagged cracks. Causes: Freezing injury; uneven soil moisture; cavity spot. Temperatures below 30°F cause cracked roots with a water-soaked appearance. Protect roots with mulch before temperatures fall.

Roots can also crack if soil is wetted after being dry. Prevent problems by keeping soil evenly moist.

Severe cases of cavity spot can cause open cracks. See "Roots with internal cavities; may split open" on page 61 for causes and controls.

Roots poorly formed or pale. Causes: Nutrient deficiency; extreme temperatures. Spindly, short roots can be caused by potassium deficiency or excessive heat. Poor color and taste are caused by magnesium deficiency, phosphorus deficiency, and low or high temperatures. Copper deficiency can also cause poor root development. Spray foliage with seaweed extract to prevent deficiencies. Do a soil test and amend soil as needed.

Cauliflower

Brassica oleracea
Botrytis group (Cruciferae)

Cauliflower is a cool-season crop grown for its dense, white heads of flower buds. Cauliflower and cabbage require similar culture and are attacked by many of the same diseases and insects. See the Cabbage entry beginning on page 52 for culture and more information on problems. Prevent problems by planting the following cultivars: 'Alpha Paloma' and 'White Rock' are tolerant of cabbage root maggots; 'Super Snowball A' tolerates flea beetles better than most cultivars.

Cauliflower is more fussy about temperatures than the other brassicas. Plants will only tolerate a low of 45°F and grow poorly above 75°F. Transplants exposed to cool temperatures (35°-45°F) for 10 days or more may form tiny, unusable flower heads. High temperatures can cause the same problem. Its optimum temperature range is 60°-65°F.

Problems

Heads with black spots on surface. Cause: Downy mildew. Control this fungal disease by spraying plants with a baking-soda-and-soap spray (1 teaspoon baking soda, 1 teaspoon liquid dish soap, 1 quart water) or copper at the first sign of disease. Repeat weekly if weather is wet. Prevent problems by planting 'Cloud Nine', which is somewhat tolerant of downy mildew.

Heads with brown or discolored curds. Causes: Light exposure; boron deficiency; cold injury. Cauliflower heads develop green or purple pigments when exposed to sunlight. To blanch cauliflower, tie the outside leaves loosely up over developing heads so that air can move through, but water cannot drip in. Save time by growing self-blanching cultivars such as 'Montano'.

Boron deficiency turns curds brown and makes them appear water-soaked. Prevent problems by spraying plants with seaweed extract when transplanted and every 2 weeks thereafter. Raise the boron level of the soil by adding 1 tablespoon of borax dissolved in 1 gallon water, or 10 pounds of kelp, per 100 square feet.

Curds will also turn brown in response to cold and freezing injury. Protect cauliflower heads with row cover below 45°F.

Heads with loose or irregular flower curds. Causes: Excessive heat; molybdenum defi-

ciency. If weather has been hot, suspect heat stress. Prevent problems by growing cauliflower as a fall crop when temperatures are cooler. Prevent molybdenum deficiency by spraying plants with seaweed extract at transplanting and every few weeks thereafter.

Cedrus

Cedar. Trees.

Cedars are among the most attractive evergreen trees. They have horizontal branching habits and bear large, upright cones. All are ideal as specimen trees.

Cedars all like a deep, loamy soil, well-drained but enriched with organic matter. Plant them in spring as small, balled-and-burlapped or container-grown plants, setting them in a sunny location. Cedars are remarkably free of serious insect pests. Keep your trees healthy by applying compost mulch and watering thoroughly during periods of drought to minimize damage.

Problems

Leaves reddish brown; branch tips die back. Cause: Deodar weevils. This ½" long, reddish brown beetle has irregular white spots on its back. It will occasionally gnaw through bark and feed on the growing tissue beneath, girdling small branches. The grubs also feed on branch tips. This pest rarely attacks healthy trees, so fertilize and water trees regularly to keep them vigorous. Drench soil around the plant with a solution of parasitic nematodes. Spray leaves with pyrethrin to control severe infestations.

Trunk or branches with oozing lesions; branch tips die back. Cause: Canker. See "Trunk or branches with oozing lesions; branch tips die back" on page 238 for more information.

Leaves yellow and wilt. Cause: Root rot. See "Leaves yellow and wilt" on page 237 for details.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. See "Leaves yellow; stems and leaves covered with small bumps" on page 237 for controls.

Celastrus

Bittersweet. Vines.

Bittersweets are vigorous twining vines with alternate leaves. The orange-red berries are popular for dried arrangements.

Bittersweets flourish in sun or partial shade in virtually any soil. Be sure to obtain both male and female plants to ensure fruiting. Control the aggressive vines by pruning them back severely each winter.

The major insect enemy of bittersweets is scales; see "Leaves yellow; stems and leaves covered with small bumps" on page 237. Powdery mildew may affect leaves; see "Leaves with powdery white coating" on page 237.

Celery

Apium graveolens var. *dulce*
(Umbelliferae)

Celery is a biennial vegetable grown for its crispy leaf stalks. It is in the same family as carrots and is troubled by many of the same pests and diseases. See the Carrot entry begin-

ning on page 60 for more information on culture and problems.

Celery does well if given plenty of moisture, rich soil with a pH between 6.0 and 6.8, and cool temperatures or light shade. Celery will withstand a light frost, but will bolt or flower prematurely and produce only a few small stalks if temperatures are below 55°F for more than 10 days when plants are young.

Celery is a heavy feeder. Boron deficiency causes brown, mottled leaves and horizontal cracks on stalks. 'Florida 683' is tolerant of low boron. Calcium deficiency causes the center of the plant to blacken and die. 'Utah 52-70R Improved' is tolerant of low calcium. Magnesium deficiency causes yellow leaves. Discolored streaks on stalks are a symptom of potassium deficiency. Phosphorus deficiency causes plants to form rosettes. Prevent problems by adding plenty of compost to the soil and by spraying plants with seaweed extract every 2 weeks. Check suspected deficiencies with soil tests and amend soil as needed.

Stalks become tough, bitter, and stringy if plants do not have enough water or nutrients, if temperatures are too high, or if they are not harvested promptly.

Problems

Leaves with dark, yellow-bordered spots. Cause: Blight diseases. Various fungal blight diseases attack celery. Stalks of afflicted plants may also develop spots or dark areas. Destroy spotted leaves. Spray plants with copper if symptoms are serious. Soak seed in 118°F water for 30 minutes before planting to prevent problems. (Be aware that this treatment can damage seed viability; for complete instructions, see page 422.) Plant cultivars, such as 'Emerson Pascal' and 'Golden Self-Blanching', that tolerate certain blights.

Leaves yellow; plant stunted; veins in stalks reddish. Cause: Fusarium yellows. Destroy plants with this fungal disease. Prevent problems by planting tolerant cultivars such as 'Bishop', 'Deacon', 'Emerson Pascal', 'Starlet', 'Summit', 'Ventura', and 'Vicar'.

Leaves yellow and mottled; stalks twisted; plant dwarfed. Cause: Celery mosaic. Destroy infected plants. Control aphids because they can spread viral diseases as they feed. Prevent problems by planting resistant cultivars such as 'Florida 683' and 'Utah 52-70R Improved'.

Leaves and stalks with irregular tan spots. Cause: Brown spot. Control this fungal disease by spraying plants with bordeaux mix when spots appear to prevent further spread.

Leaves with chewed holes or rolled edges. Cause: Caterpillars. Handpick caterpillars or spray plants with BTK to control.

Stalks or crowns rotted. Cause: Bacterial and fungal diseases. Various bacteria and fungi will rot celery stalks and crowns. Destroy infected plants. Spray remaining plants with copper. Prevent problems by controlling insect pests, such as carrot rust flies, that injure roots, creating openings for disease organisms. Also, avoid handling plants while they are wet, and plant in raised beds if possible.

Celosia

Celosia, cockscomb. Annuals.

Celosias form feathery plumes or velvety crests in shades of pink, red, orange, and yellow. Blossoms appear in summer through late fall; plants grow 7″-36″ tall. Plumed types are great in beds and borders; crested types are ideal for the cutting garden.

Give celosias a sunny, well-drained site. Plants tolerate drought and poor soils, but

they bloom poorly and become leggy if shaded. Sow seeds indoors 4 weeks before last frost, or direct-seed outdoors after the soil warms up. Cover lightly so seeds receive some light but don't dry out. Tall-growing, crested types are often top-heavy and benefit from staking.

Celosias are usually trouble-free. Careless transplanting can injure the terminal bud and reduce flowering. Damping-off may cause seedlings to rot at the soil line; see "Seedlings die" on page 20 for controls.

Centaurea

Cornflower, bachelor's-button. Annuals.

Usually seen in shades of blue, hardy cornflowers, or bachelor's-buttons, are available in red, pink, white, and violet, too. These 12"-26" high garden favorites provide 1" flowers all spring. Seeds are favored by birds, particularly finches. Use in beds and borders or for cutting.

Direct-sow outdoors in early spring where growing seasons are short, and in later summer through fall where winters are mild. Indoor seeding in April is an option, but seedlings transplant poorly. Sow evenly to avoid overcrowding, which results in weak flower stalks and slow growth. Seedlings appear in 2 weeks. Thin to 6"-9" apart.

For best results, give bachelor's-buttons full sun and rich, moist, neutral soil. They will, however, tolerate average soil and drought. Always water early in the day to give the leaves a chance to dry before nightfall. Add organic matter or fertilizer to the planting site before seeding, and do not fertilize again; extra fertilizer promotes the development of leaves rather than flowers. By midsummer, bachelor's-buttons tend to become woody and unsightly. Picking flowers prolongs bloom until July, but plan on pulling out the spent plants and replacing them with a later-blooming annual, such as marigolds or celosias.

Bachelor's-buttons have very few problems or pests. They may reseed too prolifically for some gardeners, but removing spent flowers decreases this possibility. If plants look too leggy, they are not getting enough sun; plant on a sunnier site next year. Rusts may cause orange spots on leaves; see "Stems and leaf undersides with dusty, dark brown spots" on page 21. Aster yellows can cause plants to turn yellow; see "Leaves greenish yellow; growth poor" on page 19.

Chaenomeles

Flowering quince. Shrubs.

Flowering quinces are spring-blooming deciduous shrubs with alternate leaves and thorny branches. The plants are used as deciduous hedges, in foundation plantings, or in shrub borders.

Flowering quinces require full or nearly full sun. While not particular as to soils, they prefer a good, well-drained loam. Renewal pruning (removal of a few of the oldest canes each year) is recommended to keep them flowering freely.

Aphids may feed on young shoots and leaves; see "Leaves wrinkled and discolored" on page 235. Scales may also be a problem; see "Leaves yellow; stem and leaves covered with small bumps" on page 237.

Chard

Beta vulgaris, Cicla group (Chenopodiaceae)

Chard, also known as Swiss chard, is a type of beet grown for its succulent tops. It does not form enlarged roots. Green and red cultivars are available.

Chard grows vigorously from late spring to fall frost. Plants prefer sandy, well-drained soil with a pH of 6.5-7.5. They will tolerate a wide range of temperatures and will withstand light frost. To keep leaves tender, provide chard with plenty of water and nitrogen. Compost worked into the soil at planting followed by alfalfa meal sprinkled on the soil surface after seeding usually provides chard's requirements.

Chard and beets are susceptible to the same diseases and pests. See the Beet entry beginning on page 37 for descriptions and controls.

Cherry

Prunus spp. (Rosaceae)

Cherries are deciduous trees growing to 35′ for standard-size sweet cherries (*Prunus avium*) and to 20′ for standard-size sour cherries (*P. cerasus*). These plants are hardy in Zones 4-9.

Culture

Cherries need full sun and, especially for sweet cherries, well-drained soil. Choose a site free of late spring frosts. Train sweet cherries to a central leader form and sour cherries to an open center form. For more pruning information, see "Pruning and Training" on page 101.

Mature sweet cherries need little or no annual pruning. Sour cherries need enough pruning each winter to thin out branches and stimulate a moderate amount of growth.

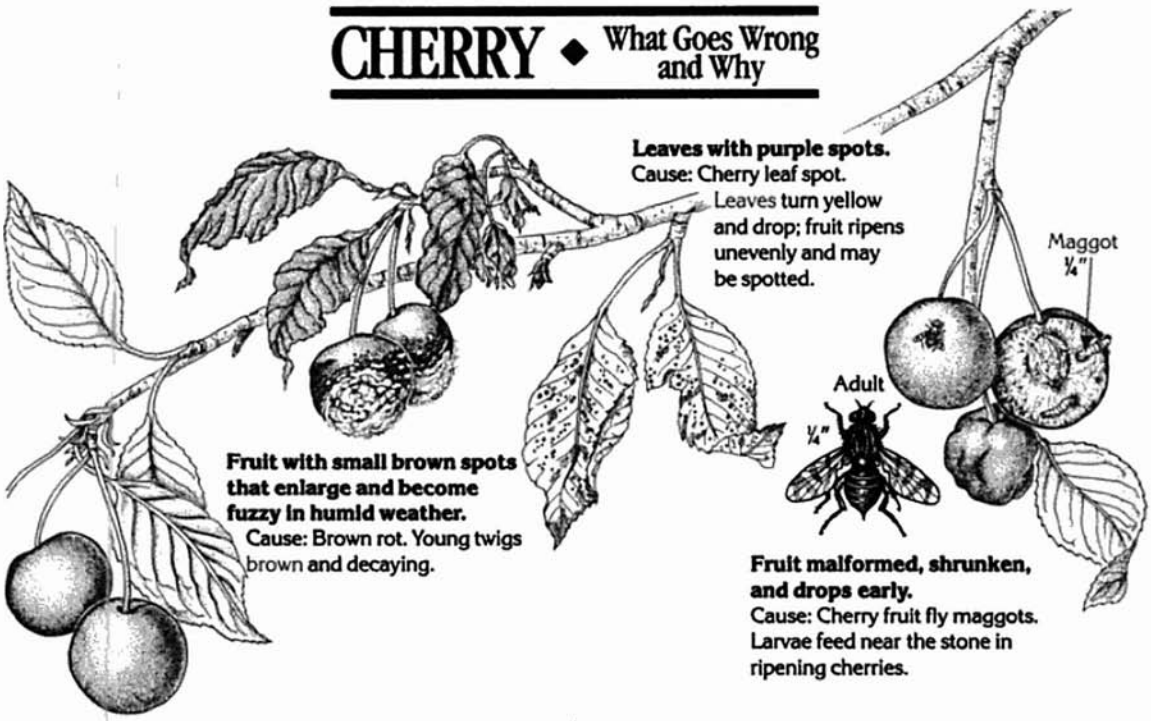
To set fruit, most sweet cherries need cross-pollination from a second compatible cultivar planted nearby. Some sweet cherry cultivars need specific cultivars for cross-pollination. A few sweet cherries, such as 'Garden Bing' and 'Stella', are self-pollinating. Sour cherries are self-pollinating. For more information, see "Setting Fruit" on page 101.

Fruit Problems

Fruit malformed, shrunken, and drops early. Causes: Plum curculio larvae; cherry fruit fly maggots. Check affected fruit for crescent-shaped scars and small, brown-headed grubs inside. These are larvae of plum curculio beetles common to the East. The crescent-shaped scar marks the site where these pests lay eggs. To control curculios without sprays, spread a dropcloth beneath the tree and jar the trunk and branches twice a day with a padded mallet. Collect and destroy curculios that fall onto the sheet. For more information see "Young fruit with crescent-shaped scars" on page 186.

Creamy white, ¼″ maggots inside fruit are the larvae of cherry fruit flies. These flies, which are half the size of houseflies, emerge in late spring from soilborne pupae and lay eggs in fruit. Eggs hatch into fruit-feeding maggots that later drop to the ground to pupate until next spring. To control this pest, trap adult flies in beginning to late May using red sticky spheres just like those for apple maggots. For instructions on making apple maggot traps see "Fruit dimpled; brown tunnels through flesh" on page 22. Collect and destroy dropped fruit daily. See the opposite page for an illustration of this pest.

Fruit with small brown spots that enlarge and become fuzzy in humid weather. Cause: Brown rot. This fungal disease may also cause


CHERRY ◆ What Goes Wrong and Why
Leaves with purple spots.
Cause: Cherry leaf spot.
Leaves turn yellow and drop; fruit ripens unevenly and may be spotted.
Maggot
¼"
Adult
¼"
Fruit with small brown spots that enlarge and become fuzzy in humid weather.
Cause: Brown rot. Young twigs brown and decaying.
Fruit malformed, shrunken, and drops early.
Cause: Cherry fruit fly maggots. Larvae feed near the stone in ripening cherries.

blossoms to turn brown and decay. Infected cherries may drop early, or remain on the tree as dried, shriveled fruit known as mummies. To control brown rot, inspect trees in early spring. Remove and destroy both mummified fruit and twigs with gummy-looking lesions. For further control, spray sulfur early in the season to control the disease on blossoms, then again later in the season to protect fruit. Copper sprays also aid control. Since injured fruit is more susceptible to brown rot, control fruit-damaging insects, such as plum curculios. See above for an illustration of this disease.

Leaf and Branch Problems

New leaves twisted or curled and covered with a sticky coating. Cause: Black cherry aphids. Look on leaf undersides for clusters of these tiny black insects. The sticky coating is honeydew secreted by these pests. Leaves also may be covered with a black fungus, called sooty mold, which feeds on honeydew. Aphids leave by midsummer, so if an infestation isn't severe, just wait it out.

For heavy infestations, knock aphids off with a strong spray of water. Or try insecticidal soap spray, which kills aphids on contact. Pyrethrin also kills aphids, but reserve this as a last resort since it also kills beneficial insects. Apply dormant oil spray in the winter to suffocate aphid eggs.

Many natural predators keep aphids in check, including parasitic wasps, lady beetles, and hover flies. To attract aphid predators, grow nectar-producing flowers, such as dill and buckwheat, near your trees, or spray commercial or homemade yeast-and-sugar mixtures on your trees. Introduced lacewings often control aphids. Buy these at commercial insectaries or from organic farm supply companies. Ants often introduce an aphid infestation; trap ants with sticky barriers around the trunks. Avoid excessive use of high-nitrogen fertilizer, which favors aphid reproduction.

Leaves covered with lacy, brownish patches. Cause: Pear slugs. These green-black, slimy creatures are not true slugs; they're the larvae of the pear sawfly, a black-and-yellow insect slightly larger than a housefly. In the spring sawflies emerge from soilborne cocoons and lay eggs on leaves. Eggs hatch into sluglike larvae that skeletonize leaves. Remove them by handpicking or with blasts of water. For heavy infestations, use insecticidal soap spray; for a dwarf tree, apply wood ashes or diatomaceous earth. (Caution: Wood ashes may damage leaf tissue.) Spider mites multiply quickly in dry, dusty conditions, so wash ashes off after a few days to avoid encouraging a rise in the spider mite population.

Growing shoots wilt and die. Cause: Oriental fruit moth larvae. Slit the stem below the wilted portion and look for a pinkish white, ½" caterpillar—the larva of an oriental fruit moth. Larvae tunnel into shoots and remain for 2 weeks before leaving to pupate for 10 days in cocoons suspended in trees. Larvae from later generations bore into and ruin fruit. Use pheromone traps to monitor and control the pests. Mating disruption pheromones, such as Isomate-M, are also effective. Replace them every 90 days throughout the growing season. For heavy infestations, spray superior oil to smother eggs and larvae.

Leaves with purple spots. Cause: Cherry leaf spot. This fungal disease, prevalent during rainy springs in the East and Midwest, causes circular purple leaf spots that later turn brown and drop out leaving small holes. Leaves may yellow and drop early. Infected trees decline in fruit production and winter hardiness. Since the disease overwinters in fallen leaves, control it by thoroughly removing leaves before spring growth begins. For persistent infection, apply lime-sulfur or sulfur spray. Since lime-sulfur discolors fruit, use it only at petal fall, then use sulfur alone for subsequent sprays. Plant leaf spot-resistant cultivars including 'Meteor' and 'Northstar' sour cherries and 'Gold', 'Lambert', 'Hedelfingen', 'Schmidt Bigarreau', and 'Viva' sweet cherries. See page 67 for an illustration of this disease.

Leaves covered with a white powdery coating. Cause: Powdery mildew. Leaves may also be twisted or stunted and a powdery coating may cover fruit. Rainy weather does not cause this fungal disease to spread. It is most common in weather patterns featuring cool nights changing to warm days. For control, apply sulfur or lime-sulfur spray. 'Northstar' sour cherry is resistant to powdery mildew.

Young twigs brown and decaying. Cause: Brown rot. With this fungal disease, limbs may develop gummy-looking lesions. For more information, see "Fruit with small brown spots that enlarge and become fuzzy in humid weather" on page 66.

Leaves wilting and dying on whole branches. Causes: Bacterial canker; Valsa canker; shothole borers. With both cankers, trees may not leaf out in the spring, and branches may develop sunken, elliptical lesions that ooze a reddish gum. With bacterial canker, this gum smells sour, and leaves may have small, angular spots. For both cankers, prune wilted or dying branches off below the infection point, sterilizing tools in isopropyl alcohol or a 10 percent bleach solution (1 part bleach to 9 parts water) between cuts. Valsa canker enters trees through bark injuries; prevent it with cultural practices that avoid bark injury. Cultivars resistant to bacterial canker include 'Bada', 'Corum', 'Early Burlat', 'Sam', and 'Sue' sweet cherries. For more information, see "Branches wilting and dying, fail to leaf out in spring" on page 167.

Dying branches covered with numerous small holes are the work of tiny beetles called shothole borers. Inside the sawdust-filled tunnels, look for white, ⅛" borer larvae with reddish brown heads. Shothole borers prefer injured or diseased trees. Vigorous, healthy trees are much less susceptible to problems.

Leaves yellowing; limb dieback. Cause: San Jose scale. Colonies of these sucking insects cling to the bark and appear as small gray bumps that can easily be scraped off with a fingernail. Control San Jose scale with dormant oil spray applied in late winter or early spring just before blossoms open.

Twigs and branches bearing tarry, black galls. Cause: Black knot. For more information, see "Twigs and branches bearing tarry, black galls" on page 187.

Whole Plant Problems

Tree lacking vigor. Cause: Peachtree borers. The larvae of a clear-winged moth, these 1", white borers create holes and a gummy exudate on trunks near or just below ground level. Either dig the borers out without damaging the tree excessively or locate borer holes and kill larvae by inserting a wire into holes. Cultivating shallowly around the base of the tree discourages these pests. Keeping your tree vigorous and avoiding mechanical damage also discourages peachtree borers.

Tree stripped of fruit. Cause: Birds. Birds especially love red sweet cherries. Plant yellow-fruited cultivars, which are somewhat less attractive to birds. Cover small trees with netting. For more information on controlling birds, see "Stopping Animal Pests" on page 408.

Chestnut

Castanea spp. (Fagaceae)

Chestnuts are deciduous trees with large, alternate leaves. The nuts are enclosed in prickly burrs, a drawback to the use of the trees for ornamental purposes.

At one time, American chestnut (*Castanea dentata*) was the dominant tree in eastern forests. It was a splendid specimen tree, highly valued for its wood and for the nuts it yielded. Unfortunately, the fungus that causes chestnut blight was introduced to the United States in the early 1900s, and virtually all American chestnuts have died back from the disease. Infected trees sometimes produce new sprouts, but they don't grow to maturity. Using these sprouts, researchers are working to develop resistant strains. Until then, blight-resistant species, such as Japanese chestnut (*C. crenata*) and Chinese chestnut (*C. mollissima*), are practical alternatives to American chestnut.

Chestnuts are not especially demanding in their soil requirements, as long as drainage is good. They are remarkably heat-tolerant. Plant in a sunny location; set out in spring or fall as balled-and-burlapped plants.

Problems

Leaves skeletonized. Causes: Cankerworms; Japanese beetles. These ½"-1" long, green, yellow, or brown caterpillars feed on foliage, often defoliating the tree. To avoid this problem, apply a band of a sticky substance, such as Tanglefoot, around the base of the tree in spring to keep females from climbing up the tree and laying their eggs. Apply fresh coats in September and February to trap both spring and fall cankerworms. If their feeding becomes a problem, spray with BTK as soon as you notice them; continue every 2 weeks until pests are gone.

Japanese beetles often feed on chestnut leaves, causing similar symptoms. See "Leaves skeletonized" on page 236 for control suggestions.

Plant defoliated. Cause: Gypsy moths. See "Plant defoliated" on page 236 for controls.

Leaves skeletonized or with large holes; branches may be webbed. Cause: Caterpillars. See "Leaves skeletonized or with large holes; branches may be webbed" on page 236 for more information.

Nuts damaged. Cause: Chestnut weevils. The larvae of this pest feed inside the nuts, and then enter the soil when the nuts fall to the ground. Pick fallen nuts from the ground daily to reduce future populations.

Trunk or branches with small holes; limbs die or break off. Cause: Borers. Several kinds of borers attack chestnuts; see "Trunk or branches with small holes; limbs die or break off" on page 238 for controls.

Chives

Allium spp. (Liliaceae)

Common chives (*Allium schoenoprasum*) are a hardy (Zone 3) perennial herb grown for their mild, onion-flavored leaves and pink flowers. Garlic chives (*A. tuberosum*) are slightly less hardy (Zone 5), and have larger, straplike leaves and white, rose-scented flowers. To grow healthy, trouble-free plants, sow seed indoors in 60°-70°F soil mix, or outdoors after soil has warmed. Chives do best in moderately rich, moist, well-drained soil with a pH between 5.0 and 7.0. Chives need full sun.

Chives are closely related to onions and prone to the same problems, especially rust, downy mildew, and smut. See the Onion entry beginning on page 155 for information.

Chrysanthemum

Chrysanthemum, garden mum. Perennials.

Early wild chrysanthemums, mentioned in 5th century B.C. writings, bore rather plain, yellow blossoms. Later, whites and purples were found and cultivated. Today, hundreds of cultivars are available. Within this genus are Shasta daisies, costmary, painted daisies, feverfew, and marguerites, in addition to the huge array of colors and blossoms found among the popular hardy mums.

Full sun and fertile, well-drained soil promote healthy mums. Fertilize plants in spring with compost or a slow-acting, general-purpose fertilizer, then give supplemental feedings monthly during the growing season; stop fertilizing in August. Start plants from stem cuttings, divisions, or seeds. When buying mums, look for compact, bushy plants, which will flower better than larger specimens. Space 1′ apart, avoiding areas already occupied by tree and shrub roots. When plants reach 6″-8″, pinch growing tips back to stimulate branching and flower bud production. Give these shallow-rooted plants ½″-1″ of water weekly; water stress causes woody stems and lower leaf drop. Overwatering, particularly when combined with poor drainage, causes yellowing leaves that blacken and drop. Cut plants back to within a few inches of the ground after blooming. Protect roots with a winter mulch.

Although the list of pests and diseases that *may* attack chrysanthemums is long, mums are relatively trouble-free. Unless mums are stressed by unfavorable growing conditions, few pests will seek them out; fewer still will cause significant damage.

Problems

Leaves, stems, and buds distorted, sticky; clusters of small insects. Cause: Aphids. See "Leaves, stems, and buds distorted, sticky; clusters of small insects" on page 177 for controls.

Leaves with yellow-brown spots or blotches; leaves die and turn brittle. Cause: Foliar nematodes. These microscopic roundworms overwinter in soil or plant debris, then travel up a plant's stem in the film of water created by spring rains, entering the lower leaves

through the stomata, which are minute openings in the leaves. Symptoms move up the plant; foliar nematodes may even infest the petals. Spots eventually cover entire leaves, which die, turn brittle, and drop. Severe infestations can kill entire plants. Remove and destroy infested plants and the surrounding soil; do not compost the debris. There is no cure; clean up debris in fall to destroy overwintering nematodes. Rotate plantings and mulch in spring to keep nematodes from climbing up plants; avoid wetting leaves when watering.

Leaves with tan or brown blotches or serpentine tunnels. Cause: Leafminers. These tiny pale green fly larvae feed between the upper and lower surfaces of leaves. Prune off and destroy infested leaves until only healthy growth remains. Remove debris in fall to destroy overwintering leafminers. Let parasitic wasps control these pests, or repel larvae with weekly insecticidal soap sprays starting when the first tunnel appears.

Leaves and flowers greenish yellow, distorted; new growth spindly. Cause: Viral diseases. Chrysanthemums are prone to several viruses, which are spread by sucking insects such as aphids and leafhoppers. Control such pests to limit virus problems. Remove and destroy infected plants; do not compost them. Wash tools used around infected plants. Viruses overwinter in perennials and weeds such as daisies and plantains.

Cimicifuga

Bugbane, snakeroot. Perennials.

The durable bugbanes are 2′-6′ tall natives that spread to 2′ wide. Small creamy white blooms appear in multiples to cover upright, slim spikes that tower above the dark green, fernlike leaves. Flowering occurs from late summer to early fall, depending on species. Flower aroma has been described as "sickly sweet" and "strange." Whether it deters pests or not remains undetermined, but parts of stinking bugbane (*Cimicifuga foetida*) are being tested as a general insect repellent.

Bugbanes prosper in rich, moist, well-drained, organic soil, similar to their native woodland habitat. These plants prefer light shade; bugbanes grown in deep shade bear fewer flowers. Plants can succeed in sunny areas with ample watering. Clumps expand outward slowly and can be divided in fall or spring, but bugbanes are deep-rooted and may suffer from division. Germination from seed is slow and inconsistent. Provide a winter mulch in colder areas, a protective summer mulch in warmer areas. Fertilize and water regularly.

Problems

Leaves with large, ragged holes. Cause: Slugs and snails. While sturdy bugbanes withstand most pest invasions well, check regularly beneath the dense clumps of foliage for slugs and snails. Differing only in the presence or absence of a shell, slugs and snails range in size from ⅛″ to 8″ and may be gray, tan, green, black, yellow, or spotted. These voracious mollusks rasp large holes in leaves and stems, leaving slimy mucus trails as they travel.

Repel slugs and snails from flower beds with a 4″-8″ strip of copper edging, or surround plant with a band of cinders, wood ashes, cedar sawdust, or diatomaceous earth, and renew frequently. Trap slugs and snails with shallow pans of stale beer set with rims flush with the soil surface; remove drowned pests daily. Or lay boards, cabbage leaves, or overturned clay pots around the garden, and destroy pests that congregate underneath. Handpick slugs and snails from plants at night; drop them into soapy water or sprinkle them with table salt to dehydrate and kill them.

Citrus

Citrus spp. (Rutaceae)

Citrus trees are evergreens that grow in flushes throughout the year. They bear fragrant flowers and fruit that hangs for months without dropping. These plants are hardy in Zones 9-10.

To flourish and bear well, citrus trees require a site with excellent drainage and full sun. Prune to remove dead wood, to keep trees in bounds, and to thin out centers where growth is too dense. Citrus flowers attract bees; don't plant them in high-traffic areas. Citrus trees bear fruit without cross-pollination.

Fruit Problems

Fruit with raised, light brown, corky areas. Cause: Citrus scab. Leaves also may show scabby lesions. This fungal disease, common in Florida, attacks mainly grapefruit, 'Temple' and 'Murcott' honey oranges, lemons, sour oranges, satsumas, and some tangelos. To control citrus scab, prune and site trees so that foliage and fruit remain as dry as possible during spring growth.

Fruit with small, brown, sunken spots that turn dark and are raised. Cause: Melanose. This fungal disease usually attacks trees more than 10 years old and is worst in wet springs. As rain washes spores over fruit, a tear-streaked pattern of infection develops. Copper spray applied just once at fruit set controls this disease, but since fruit damage is only cosmetic, spraying isn't really necessary. Keep melanose in check by pruning out dead wood, which may harbor the disease.

Fruit with firm, light brown spots on the rind. Cause: Brown rot. In humid weather brown rot may appear as a white mold on the rind. Rain splashes the spores of this fungal disease from the ground onto low-hanging fruit. The simplest control is to mulch the soil around the tree and prune away low-hanging branches. Copper spray applied to the ground and low-hanging limbs also works. This disease spreads easily in stored fruit: keep infected fruit away from clean fruit.

Fruit contains webbing. Cause: Navel orangeworms. These reddish orange, brown-headed larvae bore into cracked fruit and spin their cocoons inside. Control pests by picking off damaged fruit. Clean up dropped fruit. Spray BTK to kill larvae before they enter.

Leaf and Branch Problems

Leaves with pale yellow stipples. Cause: Citrus mites. These pests may also attack fruit causing it to turn brown or silver and drop prematurely. Pesticides tend to kill natural mite predators, so unsprayed trees are less prone to mite infestation. You can also introduce predatory mites, such as *Amblyseius* species. The simplest mite remedy is to hose down the tree with plain water or insecticidal soap solution. For more serious infestations, spray superior oil or sulfur.

Leaves with oily brown spots on undersides. Cause: Greasy spot. With this fungal disease, yellowish brown blisters on leaf undersides eventually turn oily brown and coalesce. Superficial pitting may appear on fruit rind. Since the disease overwinters on leaf litter, the simplest control is to collect and destroy fallen leaves. Wet foliage encourages spread of the fungus; keep leaves as dry as possible, especially during the early summer. For recurrent greasy spot, spray with superior oil or copper.

Trunk with brown patches exuding a thick, amber gum. Cause: Brown rot gummosis. Eventually brown patches form dark, sunken cankers. Lower branches above the canker may wither and die. This disease begins when

spores of Phytophthora fungus splash up from the ground and enter the trunk through a bark injury. To control this disease, scrape away the canker into healthy bark, allow it to dry, and spray it with copper. To prevent the disease, keep surface water and sprinkler water away from the trunk. Plant only in well-drained soil using trees grafted onto Phytophthora-resistant rootstocks, such as trifoliate orange, sour orange, and 'Troyer' citrange.

Leaves with small, dark, circular depressions bearing yellow margins. Cause: Melanose. For more information, see "Fruit with small, brown, sunken spots that turn dark and are raised" above.

Leaves turn pale green or yellow. Cause: Nutrient deficiency. If old leaves turn yellow and drop off, suspect nitrogen deficiency, a condition that sometimes occurs when cold soil slows root activity. If young leaves turn yellow with green veins, suspect iron deficiency, a condition common to wet or alkaline soils, even if the soil contains enough iron. To correct nitrogen deficiency, apply an organic nitrogen source directly to the soil. To correct iron deficiency, adjust the soil pH to be more acidic. You can also spray either of these nutrients directly on the leaves for immediate help.

Leaves turn yellow and fall; tree declines. Cause: Scales. Various types of scales infest citrus trees, causing decline. Trees may suffer from twig dieback and reduced vigor, and leaves may be covered with honeydew excreted by the scales as well as sooty mold, which feeds on the honeydew. Cottony cushion scale looks like white, cottony masses clustered on leaves, stems, and branches. Red, brown, or black scale may look like crusty, waxy, or smooth bumps on leaves, trunk, stems, or fruit. Many natural enemies keep scale insects in check. If scale infestation is heavy, introduce outside predators for additional control. You must choose the species of predator that feeds on your species of scale. For example, Vidalia beetles (*Rodolia cardinalis*) feed on cottony cushion scale, and the parasitic wasp *Aphytis melinus* preys on California red scale. Ants protect scales by destroying their natural predators, so keep ants out of trees with sticky barriers around trunks. You can also control scale by spraying specially refined superior oil.

Leaves with white, cottony masses. Cause: Mealybugs. Leaves may also be covered with a sticky honeydew excreted by the mealybugs or a black mold, which feeds on the honeydew. Natural enemies, such as lacewings, usually keep mealybugs in check, but you can speed along the process by introducing the mealybug destroyer, an Australian predatory beetle available through commercial insectaries and organic farm suppliers. Ants protect mealybugs by destroying their natural predators. Restrict ants from trees by placing sticky barriers around trunks and removing branches that droop to the ground.

New leaves curled or twisted. Cause: Aphids. Look on leaf undersides for clusters of these tiny sucking insects. Many natural enemies keep aphids in check, including parasitic wasps and hover flies. Provide food for natural predators and parasites by growing nectar-producing flowers, such as dill and buckwheat, near your trees. Or spray commercial or homemade yeast-and-sugar mixtures on your trees to attract predators. Introduced lady beetles may not control aphids effectively, but introduced lacewings often do. Ants protect aphids by destroying their natural predators, so restrict ant movement into your trees with sticky barriers around the trunks. Excessive use of nitrogen fertilizer favors aphid reproduction.

For heavy infestations, apply a strong spray of water or insecticidal soap solution to trees, making sure you spray undersides of leaves as well. Superior oil sprays kill aphid eggs. Pyrethrin also works, but use it only as a last resort since it also kills beneficial insects.

Clematis

Clematis. Vines.

Clematis are mostly deciduous vines that climb by means of their twining leaf stalks. They bear attractive flowers in a range of sizes and colors.

Clematis prefer neutral to slightly alkaline soils, well-enriched with compost. Set out small, container-grown plants in spring or fall, planting several inches deeper than when grown in the nursery. Provide some sort of support. Clematis perform best in full sun, but they do like to have their roots cool and shaded; a rich, deep, organic mulch is of great benefit. Clematis may be slow to initiate top growth; they must first establish a substantial root system.

Problems

Vines droop and shrivel. Cause: Clematis wilt. This fungal disease is one of the most serious problems for clematis. When it strikes, prune out and destroy all affected parts. If you set the plant a few inches deeper than it was growing in the nursery at transplanting time, new vines may come up from the buried stem portion and produce new, healthy topgrowth. If the whole plant dies, don't try to grow another clematis on that site.

Plant stunted; top dies back. Cause: Clematis borers. This ⅔″ long, white-bodied, brown-headed grub feeds on the roots and crowns of clematis vines. To control, cut out and destroy infested stems, and dig the larvae out of the crowns. Dig out and destroy severely infested plants.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. See "Leaves yellow; stem and leaves covered with small bumps" on page 237 for control suggestions.

Colchicum

Autumn crocus. Corms.

These hardy, autumn-flowering corms are not crocuses, despite their common name. Pink, white, or purple, 2″-4″ tall flowers bloom without foliage, which comes up in early spring and dies off by midsummer. Narrow dark green leaves grow 6″-12″ tall.

Plant autumn crocus corms in July and August, setting them 3″ deep in average, well-drained soil in full sun to light shade. Lift and separate corms after foliage fades to reduce crowding or to move plantings; replant immediately.

Almost no pests or diseases bother these corms, which are quite poisonous if eaten.

Coleus

Coleus. Annuals.

Brilliant red, maroon, cream, and green leaves make coleus a colorful addition to the shady garden. Coleus can grow to 3′ but are usually smaller. The flowers are insignificant, so pinch them off to promote leaf growth.

Sow seeds indoors 10 weeks before last spring frost. Seeds need light to germinate, so don't cover them. After the last frost, transplant outdoors into rich, well-drained soil and moderate shade. Too much sun fades leaves and causes drooping. Feed with high-nitrogen fertilizer to encourage leaf development.

Coleus are usually trouble-free. Mealybugs may feed on plants; see "Leaves and stems with white, cottony clusters" on page 20 for controls.

Clematis

Clematis. Vines.

Clematis are mostly deciduous vines that climb by means of their twining leaf stalks. They bear attractive flowers in a range of sizes and colors.

Clematis prefer neutral to slightly alkaline soils, well-enriched with compost. Set out small, container-grown plants in spring or fall, planting several inches deeper than when grown in the nursery. Provide some sort of support. Clematis perform best in full sun, but they do like to have their roots cool and shaded; a rich, deep, organic mulch is of great benefit. Clematis may be slow to initiate top growth; they must first establish a substantial root system.

Problems

Vines droop and shrivel. Cause: Clematis wilt. This fungal disease is one of the most serious problems for clematis. When it strikes, prune out and destroy all affected parts. If you set the plant a few inches deeper than it was growing in the nursery at transplanting time, new vines may come up from the buried stem portion and produce new, healthy topgrowth. If the whole plant dies, don't try to grow another clematis on that site.

Plant stunted; top dies back. Cause: Clematis borers. This ⅔″ long, white-bodied, brown-headed grub feeds on the roots and crowns of clematis vines. To control, cut out and destroy infested stems, and dig the larvae out of the crowns. Dig out and destroy severely infested plants.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. See "Leaves yellow; stem and leaves covered with small bumps" on page 237 for control suggestions.

Colchicum

Autumn crocus. Corms.

These hardy, autumn-flowering corms are not crocuses, despite their common name. Pink, white, or purple, 2″-4″ tall flowers bloom without foliage, which comes up in early spring and dies off by midsummer. Narrow dark green leaves grow 6″-12″ tall.

Plant autumn crocus corms in July and August, setting them 3″ deep in average, well-drained soil in full sun to light shade. Lift and separate corms after foliage fades to reduce crowding or to move plantings; replant immediately.

Almost no pests or diseases bother these corms, which are quite poisonous if eaten.

Coleus

Coleus. Annuals.

Brilliant red, maroon, cream, and green leaves make coleus a colorful addition to the shady garden. Coleus can grow to 3′ but are usually smaller. The flowers are insignificant, so pinch them off to promote leaf growth.

Sow seeds indoors 10 weeks before last spring frost. Seeds need light to germinate, so don't cover them. After the last frost, transplant outdoors into rich, well-drained soil and moderate shade. Too much sun fades leaves and causes drooping. Feed with high-nitrogen fertilizer to encourage leaf development.

Coleus are usually trouble-free. Mealybugs may feed on plants; see "Leaves and stems with white, cottony clusters" on page 20 for controls.

coreopsis' tendency to self-sow. Divide clumps every 3-4 years.

Problems

Leaves, stems, and buds distorted, sticky; clusters of small insects. Cause: Aphids. See "Leaves, stems, and buds distorted, sticky; clusters of small insects" on page 177 for controls.

Buds and leaves deformed or dwarfed. Cause: Four-lined plant bugs. For recommended controls, see "Buds and leaves deformed or dwarfed" on page 178.

Leaves stippled, distorted. Cause: Aster leafhoppers. Greenish yellow pests only ⅛" long, these insects feed on leaf undersides, giving foliage a finely mottled look; leaves yellow, shrivel, and drop. Besides injury from feeding, leafhoppers transmit the disease aster yellows. Use water or insecticidal soap sprays to dislodge nymphs; encourage enemies such as bigeyed bugs and parasitic wasps. For control of severe infestations, spray plants with neem or pyrethrin.

Corn

Zea mays var. *rugosa* (Gramineae)

Corn is an annual vegetable grown for its large ears of tasty kernels. Sweet corn is harvested when the ears are tender and immature. Sweet corn cultivars are classified in 3 groups: normal sugary (traditional corn flavor, hybrid or open-pollinated), sugar enhanced (increased tenderness and sweetness, hybrid), and supersweet (God's gift to sweet-toothed corn lovers, hybrid). Be sure to plant supersweets at least 25′ away from any other corn cultivars or cross-pollination will cause starchy, tough kernels. Be aware that whether you plant other cultivars or not, supersweet cultivars generally suffer from more than their share of pests.

While most gardeners stick to sweet corn, other types of corn are just as easy to grow. Popcorn, ornamental corn, and field corn are harvested when the seeds are hard and mature and the husks are dry. Popcorn is popped for a tasty, low-calorie snack. Dent (field) corn and flint (Indian) corn cultivars are used for cornmeal and decoration. Flour corn is starchy and used for flour and decoration.

Culture

Corn does best in a rich, sandy, or well-worked soil with a pH between 5.5 and 6.8. Prepare soil by working in a generous amount of compost. Side-dress plants with alfalfa meal when they are 1′ high and again when silk first shows at the end of the ears. Spraying plants with seaweed extract or compost tea periodically also improves your harvest and prevents deficiencies.

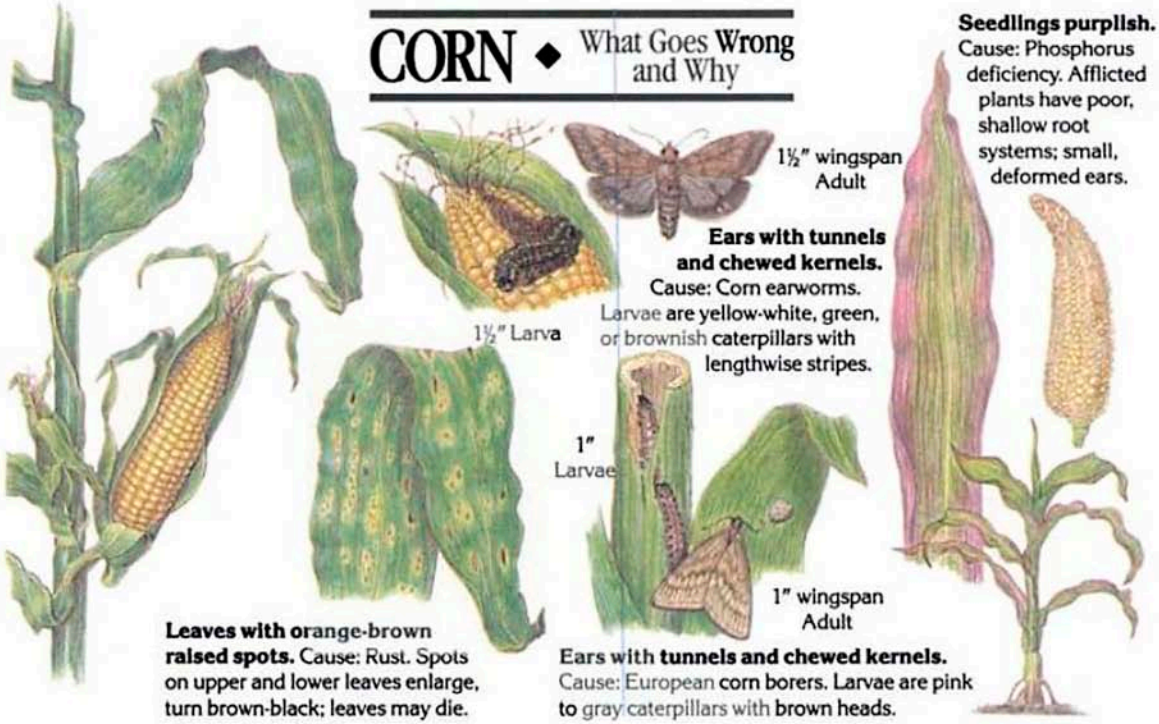
Plant corn seed only after the soil is at least 60°F, or 75°F for supersweets. Seed planted in cooler soil is prone to many problems, including poor germination. To help speed soil warming, cover soil with clear plastic at least 2 weeks before you want to plant. After planting, use row cover for about a month to give seedlings a boost.

Corn needs at least 1″ of water a week. Keep soil moist, but not soggy. Mulch plants to conserve moisture and cut down on weed competition.

Plant corn in blocks rather than long single rows to ensure good pollination. Do not plant corn where it has grown in the past 2 years to prevent problems. After harvest cut or mow stalks and let them dry. Then turn them under or collect and compost them. Destroy any diseased or infested material.

Leaf and Whole Plant Problems

Seedlings cut off at ground level; leaf margins ragged. Cause: Cutworms. Young cut-


CORN ◆ What Goes Wrong and Why
1½" wingspan Adult
Seedlings purplish. Cause: Phosphorus deficiency. Afflicted plants have poor, shallow root systems; small, deformed ears.
Ears with tunnels and chewed kernels. Cause: Corn earworms. Larvae are yellow-white, green, or brownish caterpillars with lengthwise stripes.
1½" Larva
1" Larvae
1" wingspan Adult
Leaves with orange-brown raised spots. Cause: Rust. Spots on upper and lower leaves enlarge, turn brown-black; leaves may die.
Ears with tunnels and chewed kernels. Cause: European corn borers. Larvae are pink to gray caterpillars with brown heads.

worms feed on leaves. Most cutworms are gray or dull brown and up to 2″ long. Spray seedlings with BTK in the evening if cutworms are still feeding on leaves. Sprinkle moist bran mixed with BTK on the soil surface in the evening, or add parasitic nematodes to the soil to control stem-girdling cutworms. For small plantings, place cutworm collars around plants or groups of plants to prevent damage.

Seedlings fail to emerge or are stunted. Causes: Cool soil; corn rootworms; seedcorn beetles; wireworms; seedcorn maggots; white grubs. Corn seed germinates poorly in cool soil and is more prone to insect damage and rots. Plant after soil is warm to prevent problems. Do not plant corn where grass grew the year before because many pests live in sod.

Corn rootworms are white, slender, ½″ long larvae with brown heads. Adults are beetles. Western rootworm beetles are ¼″ and yellow with 3 black stripes. Northern rootworm adults are yellow to pale green, and southern rootworms (spotted cucumber beetles) are yellow-green with 11 black spots. Rootworm larvae feed on seeds, and adults feed on leaves, silks, and tassels.

Seedcorn beetle larvae are white, slender, ½″ long grubs; adults are ⅓″ long ground beetles with light brown edges. Both larvae and adults feed on seeds.

Wireworms are 1½″ long, yellow to reddish brown, slender, tough-bodied, segmented larvae with brown heads. Adults are dark-colored, elongated click beetles.

Seedcorn maggots are ¼″ long, yellow-white, and spindle-shaped. Adults are small flies. White grubs have thick, soft, ¾″ bodies and curl into a C-shape when disturbed. Adults are Japanese or June beetles. Wireworms, seedcorn maggots, and white grubs eat corn seed.

Apply parasitic nematodes to the soil before planting to control soil-dwelling pests.

Copyrighted material

Prevent adults from laying eggs on or near seedbed by covering it with a large piece of row cover after planting. Remove row cover when tassels appear.

Seedlings purplish. Cause: Phosphorus deficiency. See page 77 for an illustration of this condition. Phosphorus is not readily available in cool soils. Spray plants with seaweed extract or compost tea to alleviate symptoms.

Plant stunted and yellow. Causes: Nitrogen deficiency; too much or too little water; nematodes. If older leaves turn yellow first, suspect nitrogen deficiency. Drench roots and spray plants with fish emulsion or compost tea to alleviate symptoms.

To avoid root damage, keep the soil evenly moist. Plant in raised beds to ensure good drainage.

If entire plant is yellow and doesn't green up when sprayed with seaweed or compost, and soil is well-drained and not too dry, suspect pest nematodes. Roots may be stubby or have swellings or beadlike galls. Control by applying chitin or parasitic nematodes to soil.

Leaves yellow and curled; plant stunted. Cause: Aphids. These small, soft-bodied, green, black, gray, pink, or white fluffy-coated insects suck plant sap. For mild infestations, knock pests off plants with a blast of water. Spray infested plants with insecticidal soap, or use a commercial neem or pyrethrin spray for severe infestations.

Leaves mottled yellow and green. Cause: Maize dwarf mosaic. The stem doesn't grow normally, so new leaves are very close together. Leaves may develop lengthwise stripes. There is no cure; destroy infected plants. Prevent problems by controlling aphids, which spread the virus as they feed, and perennial weeds such as Johnsongrass that can harbor the disease. Plant tolerant cultivars such as 'Bellringer', 'Bi-guard', 'Bunker Hill', 'Earlibelle', 'Enforcer', 'Merit', and 'Silverette'.

Leaves with lengthwise yellow stripes; plant may wilt. Cause: Bacterial wilt. Leaves are dwarfed. Cut off the infected plant near the soil line and look for yellow bacterial slime oozing from the cut stem to confirm diagnosis. Destroy infected plants. Control flea beetles and cucumber beetles that spread the disease. Prevent problems by planting resistant cultivars such as 'Bellringer', 'Bunker Hill', 'Buttersweet', 'Earlibelle', 'Gold Cup', 'Merit', 'Silverado', 'Silver Queen', 'Stylpak', 'Summer Pearl', and 'Sweet Sue'.

Leaves with yellow, tan, or gray spots or blotches. Causes: Northern or southern corn leaf blight; other fungal leaf spots. Spray infected plants with sulfur to prevent blight from spreading. Prevent problems by using a 3-year rotation for corn and by planting cultivars, such as 'Sweet Sal' and 'Ultimate', that are tolerant of northern leaf blight or 'Apache', 'Cherokee', 'Comet', 'Florida Staysweet', and 'Wintergreen', which resist both blights.

Leaves with orange-brown raised spots. Cause: Rust. See page 77 for an illustration of this disease. Spray infected plants with sulfur early in the day and thin plants to maintain good air circulation. If rust is a recurrent problem, try spraying plants with an antitranspirant before symptoms develop to prevent infection. (Do not spray with antitranspirant when corn is silking.) Plant rust-tolerant cultivars such as 'Earlibelle', 'Flavor King', 'Summer Pearl', and 'Sweetie 82'.

Leaves with numerous small holes. Causes: Flea beetles; billbugs. Leaves may develop bleached-out spots or stripes. Flea beetles are tiny black insects that hop when disturbed. They can transmit disease and are likely to be more numerous after mild winters. Cover plants with row cover as soon as they come up to exclude beetles. Remove row cover when tassels form. Treat plants with a commercial neem or pyrethrin spray to control severe infestations.

If holes are arranged in rows, look for billbugs. These hard-shelled, nearly black, ¼"-½" snout beetles are usually seen only at

night. Spray heavily infested corn plants with pyrethrin.

Leaves with large, ragged holes. Causes: Corn earworms; European corn borers; armyworms; other caterpillars. Handpick or spray plants with BTK if caterpillars are feeding. See "Ears with tunnels and chewed kernels" below for controls.

Leaves skeletonized. Cause: Japanese beetles. Silk and tassels may be chewed. Adults are ½" long, metallic blue-green beetles with bronze wing covers. Handpick or trap adults. Reduce beetle population in following years by applying parasitic nematodes or milky disease spores to garden and lawn areas.

Stems girdled at base; stems and ears with tunnels. Cause: Southwestern corn borers. These white, dark-spotted, brown-headed larvae bore into stalks and ears. To reduce future damage, plant corn early and use resistant cultivars. Cut corn stalks down at the soil level and remove them right after harvest.

Ear Problems

Ears with tunnels and chewed kernels. Causes: Corn earworms; European corn borers; fall armyworms. Leaves and silk may be chewed. Stalks and tassels may be tunneled and may snap off. Corn earworm larvae are light yellow, green, pink, or brown caterpillars up to 2" long, with lengthwise stripes. Adults are tan moths. See page 77 for an illustration of this pest.

European corn borer larvae are beige, brown-spotted caterpillars up to 1" long, with brown heads. Adults are pale yellow to tan moths with wavy lines on their wings. See page 77 for an illustration of this pest.

Armyworm larvae are greenish brown caterpillars up to 1½" long, with a characteristic inverted Y on the head. Adults are pale gray moths and have a 1½" wingspan.

Cover plants with row cover until tassels emerge to exclude the first generation of pests, especially if you have had problems in previous years.

Use insect-specific pheromone traps to catch male moths of various pest species, or ask your local extension agent when moths appear in your area. If you are growing large quantities of corn, you may want to try using a blacklight trap to catch all types of moths; be aware that many kinds of beneficial insects are also attracted to and killed by these traps. When moths are present, spray plants with pyrethrin in the evening to prevent pests from laying eggs.

Even before the tassels emerge, check the upright, topmost leaves of your plants every 2-3 days for signs of caterpillar feeding. Spray BTK as soon as any feeding holes are found. Make sure to spray the undersides of leaves and insides of unfolding leaves where pests feed.

Once silks appear, spray them with BTK or sprinkle a few grains of granular BTK directly on each silk. Apply a few drops of mineral oil to each silk 4-5 days after they wilt to discourage any resident pests, or inject a few drops of parasitic nematode suspension around the tip of the ear to kill larvae.

Kernels at tips or upper half of ears hollowed out. Cause: Sap beetles. These small black beetles with yellow spots invade ears after the silks turn brown. Handpick beetles, or spray ear tips with a commercial pyrethrin solution for severe infestations. Sap beetles can be trapped in containers baited with fermenting fruit.

Ears with dried tips exposed; ears stripped or missing. Causes: Birds; raccoons. Birds peck at tips of ears, exposed tips turn dry and greenish brown. Raccoons harvest ripe, juicy corn, usually the night before you would pick it yourself. Repel birds with loud noises or visual scare devices. Frustrate raccoons by surrounding your corn with a 3-strand electric fence with wires 3"-4" apart and off the ground. See "Stopping Animal Pests" on page 408 for further information.

Ears misshapen or with areas of undeveloped kernels. Causes: Poor pollination; nutrient deficiency; viral diseases. Insufficient or ineffective pollination can cause undeveloped bare tips, scattered kernels, or entirely bare cobs. Plant corn in a block, rather than a long row to ensure effective wind pollination. Insects feeding on silks before pollination occurs can prevent pollination, as can very dry conditions. Control insects that feed on silk, and keep soil moist, but not wet, to ensure even pollination.

Ears with bare, undeveloped tips can also be caused by potassium deficiency. Phosphorus deficiency also causes small, irregular ears. See page 77 for an illustration of this condition. If ears are misshapen and kernels have corky, brown bands at their bases, suspect boron deficiency. Spray young plants with seaweed extract or compost tea to help prevent deficiencies. Confirm deficiencies with a soil test and amend soil as needed.

Viral diseases such as maize dwarf mosaic can cause poor kernel formation at base of ears or bare ears. See "Leaves mottled yellow and green" on page 78 for more symptoms.

Ears or tassels with enlarged galls. Cause: Corn smut. Young galls are firm and whitish, older ones are spongy and filled with black powder. Remove galls before they split open, and destroy infected plants. Do not compost them. Prevent problems by planting resistant cultivars such as 'Bellringer', 'Gold Cup', 'Merit', 'Sweet Sue', and 'Viking'.

Cornus

Dogwood. Shrubs and small trees.

Dogwoods are deciduous trees or shrubs, usually with opposite leaves. These plants provide year-round landscape interest with their showy flowers, attractive fruit, striking fall color, and interesting bark. Use dogwoods as specimen plants, in woodland plantings, or as informal barriers.

Culture

Spring is the best time to plant dogwoods, as balled-and-burlapped or container-grown plants. Most thrive in well-drained soil enriched with organic matter. The tree forms, in particular, are intolerant of drought, so water them thoroughly in dry periods. A deep organic mulch helps to conserve moisture and keep down weeds. The shrub types will grow in sun or partial shade; the trees are best in dappled shade.

Dogwoods vary widely in their susceptibility to pests and diseases. Some, such as flowering dogwood (*Cornus florida*), tend to have more problems than resilient species like kousa dogwood (*C. kousa*) and cornelian cherry dogwood (*C. mas*). To avoid problems with any dogwood, keep plants growing vigorously with regular watering and fertilization. Avoid damaging the trunk with lawn mowers, string trimmers, or pruning equipment; many dogwood problems, like canker and borers, enter plants through wounds in the bark.

Problems

Trunk with lumpy swellings; limbs die or break off; bark falls off. Cause: Borers. Several species of borers attack dogwoods. The most common type, the dogwood borer, has white-bodied, brown-headed larvae. They hatch from eggs laid on the bark and enter the tree through wounds or scars in the bark. Dogwood borers often attack young, newly transplanted trees.

Although tree wraps have long been recommended to protect dogwoods from borers, research has shown that these guards are not a good idea. They tend to keep bark soft and moist, actually protecting borer larvae. If you

want to use a tree wrap to protect plants from winter deer damage, remove the guard during the growing season. Also, avoid wounding the trunk with lawn mowers, string trimmers, or pruning equipment; these injuries provide an easy entrance for borers. Preventive measures are the best control for these pests. If borers do strike, try cutting them out of the trunk with a sharp knife. Remove and destroy seriously infected trees.

Leaves with small, purple-rimmed spots or large brown blotches; twigs die back. Cause: Dogwood anthracnose. This fungal disease can be a serious problem on flowering dogwood. Lower branches die back as the disease progresses; eventually the whole tree may die. The problem is most serious in woodland settings, where the dogwoods may already be weakened by lack of light and competition for food and water. Vigorously growing plants are more resistant. If disease does strike, prune out affected parts; clean up and destroy fallen leaves in autumn. A dormant spray of lime-sulfur or bordeaux mix may give some control.

Leaves yellow, sparse, distorted, or with brown edges; branches die; growth stunted. Cause: Decline. In recent years, flowering dogwoods have been afflicted by decline. The exact cause is unknown. Trees that are stressed by insects, disease, or environmental changes are very susceptible to further pest and disease problems. Dogwood anthracnose (see above) commonly attacks already weakened trees, for example. For more information, see "Leaves yellow, sparse, distorted, or with brown edges; branches die; growth stunted" on page 238.

Twigs die back. Cause: Twig blight. Prune off affected parts back to live wood. Keep the tree growing vigorously with regular watering and fertilization.

Trunk or branches with oozing lesions; branch tips die back. Cause: Canker. See "Trunk or branches with oozing lesions; branch tips die back" on page 238 for more information.

Twigs with clublike galls. Cause: Gall midges. The orange larvae of these small reddish brown midges tunnel into young shoots. One-inch-long swellings form around the developing larvae on the twig; leaves on the branch may wilt or turn brown. Prune off and destroy galls as soon as you see them.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. See "Leaves yellow; stem and leaves covered with small bumps" on page 237 for controls.

Leaves tunneled. Cause: Leafminers. See "Leaves tunneled" on page 237 for suggested controls.

Leaves with powdery white coating. Cause: Powdery mildew. See "Leaves with powdery white coating" on page 237 for controls.

Cosmos

Cosmos. Annuals.

The daisylike flowers of these fast-growing plants come in many shades of red, yellow, white, pink, lavender, and magenta. Cosmos bloom on 1½'-4', slender stems covered with finely cut foliage.

Direct-sow cosmos outdoors from March through July. Seedlings appear in 10 days. Cosmos are also easy to transplant. Space plants 8"-24" apart, depending on ultimate size. They prefer full sun and light, average soil kept slightly on the dry side. Avoid overwatering, and do not fertilize.

Pinch back seedlings before flower buds form to encourage compact bushy plants, or buy lower-growing cultivars. Staking is necessary for larger cosmos. Plant in groups or among sturdier bedding plants for extra wind protection. Plants may self-sow.

Problems

Stems break. Cause: Stalk borers. These long, thin, striped caterpillars eat their way through cosmos stalk centers. Small, round stem holes may betray their presence. Once plants are visibly affected, there is no cure. If borers are a regular problem, spray plants with BTK early in the season as borers enter plants.

Leaves, stems, and buds distorted. Cause: Aphids. See "Leaves, stems, and buds distorted" on page 20 for controls.

Leaves greenish yellow; growth poor. Cause: Aster yellows. For more information and control measures, see "Leaves greenish yellow; growth poor" on page 19.

Plant wilts suddenly. Cause: Bacterial wilt. This disease causes a soft rot at the base of the stem, killing plants quickly. Remove and destroy infected plants. Do not replant cosmos in that area.

Cotoneaster

Cotoneaster. Shrubs.

Cotoneasters are alternate-leaved evergreen or deciduous shrubs with persistent red or black fruit. They are useful as groundcovers, in the rock garden, in foundation plantings, or overhanging a wall.

Plant in spring as balled-and-burlapped or container-grown plants. Although not particular as to soils, avoid poorly drained sites. Cotoneasters do best in full sun. Cotoneasters can withstand wind, dry soil, and even salt spray.

Problems

Leaves, flowers, and branches blackened. Cause: Fire blight. This bacterial disease causes new shoots to wilt suddenly, turn dark, and die back. The disease eventually spreads, killing the whole plant. Lush new growth is particularly susceptible, so avoid overfertilizing. Prune out diseased tissue, cutting back at least 6″ beyond the discolored area; destroy or dispose of prunings. Disinfect pruners after each cut in a 10 percent bleach solution (1 part bleach to 9 parts water) to avoid spreading the disease to healthy wood. Spray copper or bordeaux mix the following spring during flowering.

Leaves wrinkled and discolored. Cause: Aphids. See "Leaves wrinkled and discolored" on page 235 for controls.

Leaves pale and mottled. Cause: Lace bugs. These ⅛″–¼″, dark-colored bugs have lacy wings. They feed on the undersides of leaves and deposit small black spots of excrement. Severe infestations can cause early leaf drop. Control by spraying leaves with superior oil or insecticidal soap.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. See "Leaves yellow; stems and leaves covered with small bumps" on page 237 for more information.

Leaves skeletonized; branches webbed. Cause: Cotoneaster webworms. These ½″, yellowish green to brown caterpillars feed on leaves and spin silken webs around leaves and stems. Young plants may die; older ones can be seriously weakened. Break up and remove the webs; spray plants with BTK.

Leaves stippled with yellow; foliage webbed. Cause: Spider mites. See "Leaves stippled with yellow; foliage webbed" on page 236 for controls.

Leaves with brownish blisters underneath. Cause: Pear leaf blister mites. These microscopic mites live and feed on tissue inside leaves. They overwinter on buds and infest new leaves in spring. Spray plants in late winter with dormant oil or lime-sulfur.

Trunk or branches with small holes; limbs die or break off. Cause: Borers. See "Trunk or branches with small holes; limbs die or break off" on page 238 for controls.

Crataegus

Hawthorn. Trees.

Hawthorns are small, thorny, deciduous trees with alternate leaves and showy, white, pink, or red flowers. Hawthorns make attractive specimen trees, barriers, or hedges.

Set out balled-and-burlapped plants in full sun in early spring. Hawthorns are undemanding as to soil, but avoid poorly drained areas. Choose planting sites with good air circulation to minimize disease problems. To avoid rust diseases, don't plant hawthorns where Eastern red cedar (*Juniperus virginiana*) is common.

Hawthorns share many insect and disease problems with apples. For symptoms and controls, see the Apple entry beginning on page 21.

Crocus

Crocus. Corms.

Much like the first robins, dainty crocuses signal spring's arrival. These low-growing flowers bear blooms of yellow, white, pink, and purple amid dark green, grasslike foliage in late winter and early spring. Fall-blooming species include showy crocus (*Crocus speciosus*), a blue- or white-flowered plant that blooms before leaves extend fully. Most species grow only 3"-6" tall.

Plant both spring- and fall-flowering species as soon as corms are available. Corms are occasionally infected with dry rot; examine corms carefully when purchasing (see the illustration on page 49). Full sun and well-drained soil are crocuses' main requirements; corms will grow and multiply undisturbed for years. Set 3"-4" deep and 2"-6" apart with pointed growing tips right side up. Avoid cutting foliage back until it fades naturally; early removal of leaves reduces flowering in subsequent years. Divide large clumps, as needed, after leaves die back; replant full-size corms and cormels (small corms growing from base of parent corm) immediately.

Problems

Leaves, stems, and buds distorted, sticky; clusters of small insects. Cause: Aphids. Aphids may feed on foliage; see "Leaves, stems, and buds distorted, sticky; clusters of small insects" on page 51 for control information.

Plant disappears; corms missing. Cause: Animal pests. Rodents such as mice, voles, squirrels, and gophers all will eat crocus corms and can quickly make a planting disappear. The presence of a pet dog or cat often deters rodents; if pets aren't an option, try other techniques (see "Stopping Animal Pests" on page 408). Line planting beds with screen or hardware cloth to keep pests from burrowing around corms. Lay mesh over the top, too; crocus shoots can still squeeze through.

Leaves yellow, distorted; flowers absent; corms rotted. Cause: Bulb mites. If you suspect these pests, dig the corms and use a magnifying glass to look for whitish, 1/50"-1/25" mites. Bulb mites favor rotting bulbs, but move from there into healthy bulbs, carrying harmful bacteria and fungi with them. Their feed-

ing causes corky, brown spots that become powdery. Inspect corms carefully for damage or signs of infestation. Destroy badly infested bulbs and discard surrounding soil. Solarize the soil before planting corms in previously infested ground.

Cucumber

Cucumis sativus (Cucurbitaceae)

Cucumbers are annual vegetables grown for their crisp and crunchy fruit. They add life to summer salads and make tasty pickles.

Culture

Cucumber seeds need 60°F soil to germinate, so wait until weather is warm to plant. Make a second planting 4-5 weeks after the first so you will have fruit all season. Cover plants with floating row cover to protect them from insects and late cold snaps. Remove row cover when plants begin to flower so insects can pollinate the blossoms, or you will not get any fruit.

Cucumbers do best in well-drained, loose-textured soils with lots of organic matter. They will grow in soils with a pH between 5.5 and 6.8, but prefer a pH above 6.0. Plants need lots of water, but don't let soil become saturated. Prevent disease problems by keeping leaves dry. Mulch cucumbers to help conserve water; black plastic is a good choice for central and northern areas, but in extremely warm areas it can warm the soil too much. Organic mulches are good, too, but may provide shelter for pests like squash bugs. Foil mulches help prevent aphid problems. If rotting fruit is a problem, raise fruit off the ground by placing scraps of wood under them.

Rotate crops so that no member of the cucurbit family (squash, melon, and cucumber) is grown in the same place more often than every 4 years.

Caution: Cucumber leaves are easily burned by insecticidal soap and copper sprays. Use the most dilute spray recommended and use sparingly. Do not spray plants in direct sun or if temperatures are above 80°F, and don't spray drought-stressed plants.

Leaf and Vine Problems

Leaves with chewed holes. Cause: Cucumber beetles. Adults are ¼" long, greenish yellow beetles with black stripes or spots. See page 214 for an illustration of the insects and damage. They attack young leaves and should be controlled immediately, as they can spread bacterial wilt or viruses. Treat plants with a commercial pyrethrin spray or dust. Prevent problems by planting cultivars, such as 'Liberty' and 'Wisconsin SMR58', that are tolerant of cucumber beetles.

Leaves with pale green patches; afflicted leaves wilt and blacken. Cause: Squash bugs. Adults are brownish black, ½" long bugs. Immature bugs are whitish green or gray with dark heads and legs. Both emit a strong, sharp smell when crushed. Eggs are bright orange and laid on undersides of leaves. See page 214 for an illustration of the insect and its damage. Handpick adults and eggs. Trap bugs by laying a board near plants. Squash bugs will hide underneath it and can be destroyed each morning.

Leaves with yellow patches; older leaves mottled and distorted. Cause: Mosaic. For an illustration of this disease, see page 214. Remove and destroy diseased plants. Control aphids and cucumber beetles because they spread the virus. Reduce problems by planting cultivars, such as 'Comet', 'Fancipak', 'Liberty', 'Monarch', 'Score', 'Slicemaster', 'Striker', and 'Wisconsin SMR58', that are

resistant to mosaic diseases.

Leaves yellow, curled, and wilted. Cause: Aphids. Look for small, green, pink, gray, black, or white fluffy-coated, soft-bodied insects feeding on plants. Aphids can also transmit viruses. For mild infestations, knock pests off plants with a blast of water. Control with a weak insecticidal soap spray; see the caution on page 213 before spraying. Prevent problems by using a foil mulch, which keeps aphids from finding plants.

Leaves mottled yellow between veins; leaf undersides have purple spots. Cause: Downy mildew. As the disease progresses, older leaves turn brown and die and younger leaves become infected. Treat plants with a dilute solution of copper spray to control; see the caution on page 213 before spraying. Prevent problems by planting tolerant cultivars such as 'Fancipak', 'Liberty', 'Poinsett 76', and 'Slicemaster'.

Leaves with spots, blotches, or brown areas. Causes: Powdery mildew; angular leaf spot; scab anthracnose. Various diseases attack cucumbers. Reduce problems by keeping foliage dry when watering and by not touching plants when wet. Spray infected plants with a dilute solution of copper spray to control outbreaks; see the caution on page 213 before spraying.

Powdery white spots on leaves, especially on upper surfaces are caused by powdery mildew. Prevent problems by planting resistant cultivars such as 'Fancipak', 'Liberty', 'Poinsett 76', and 'Slicemaster'.

Water-soaked spots that turn gray, die, and drop out leaving shotholes are caused by angular leaf spot or by scab. Angular leaf spot causes small, brown, angular spots on fruit. Scab-damaged fruit develops sunken, brown spots with a sticky ooze. Scab is worse in cool, moist weather. 'Fancipak', 'Score', and 'Slicemaster' are resistant to scab.

Yellow spots that turn brown are caused by anthracnose. Infected leaves eventually die. Infected fruit has circular, black, sunken cankers. Prevent problems by planting cultivars, such as 'Fancipak', 'Liberty', 'Poinsett 76', 'Score', and 'Slicemaster', that are resistant to anthracnose.

Vines wilt suddenly. Cause: Squash vine borers. These fat, white, 1″ long larvae burrow into stems and exude masses of yellow-green, sawdustlike excrement. See the illustration of this insect and its damage on page 214. Slit stems lengthwise above each injury with a sharp knife and kill the larvae. Cover cut stems with moist soil so stems will form new roots. Injecting stems with BTK or parasitic nematodes may also help control borers. To reduce problems, plant the cultivar 'Sweet Mama Hybrid', which is resistant to vine borers. Or spray the base of stems with BTK once a week in late spring and early summer.

Vines wilt at midday, starting with younger leaves; leaves remain green. Cause: Bacterial wilt. See the illustration of disease damage on page 148. As the disease progresses, leaves fail to recover, and die. Cut wilted stems and press out drops of sap. If it is milky, sticky, and astringent, your plant is infected. Destroy infected plants immediately. Prevent problems by controlling cucumber beetles, since they spread the disease.

Fruit Problems

Fruit shrivels. Cause: Bacterial wilt. See "Vines wilt at midday, starting with younger leaves; leaves remain green" above for controls.

Fruit misshapen, one end not filled out. Causes: Diseases; poor pollination; nutrient deficiency. Many diseases cause misshapen fruit; use leaf symptoms to determine the disease causing the problem. If leaves are healthy, high temperatures may have damaged pollen, or bees may not have been active. Early in the season, wait for better conditions, or pollinate the flowers yourself by dusting pollen from male flowers onto female flowers (see page 214 for an illustration of male and female

Copyrighted material

flowers). Later in the season, pull plants and wait for second planting to bear. If plants appear to be healthy and temperatures are not extreme, try spraying plants with compost tea to correct possible nutrient deficiency.

Fruit with spots; flesh may rot. Causes: Angular leaf spot; Alternaria blight; black rot; scab; other fungal or bacterial diseases. See "Leaves with spots, blotches, or brown areas" on page 85 for controls.

Fruit dull bronze. Cause: Phosphorus deficiency. Spray plants with compost tea to correct possible nutrient deficiency. Check with a soil test and amend soil as needed.

Currant

Ribes spp. (Saxifragaceae)

Currants are upright or spreading, deciduous bushes growing 3'-5' high. European black currants (*Ribes nigrum*)bear fruit mostly on the previous season's growth; red and white currants (*R. petraeum, R. rubrum,* and *R. sativum*) bear on the previous season's growth and on spurs—short branches that elongate only a fraction of an inch per year—on older stems. Currants are hardy in Zones 3-8.

Plant currants in full sun or partial shade and apply a thick, organic mulch. To winter-prune red and white currants, cut all but 6 of the previous season's shoots to the ground. Remove all shoots more than 3 years old. To winter-prune black currants, cut 2-5 of the oldest branches to the ground and shorten tall, old branches to vigorous young sideshoots. Most currants are self-pollinating.

Problems

Leaves blistered and reddened. Cause: Aphids. You'll find these tiny insects clustered on leaf undersides. If damage is not severe, ignore it; otherwise, spray with insecticidal soap, neem, or pyrethrin, making sure to get the undersides of the leaves. Dormant oil applied in the winter helps prevent aphids.

Leaves yellow; stems die back. Cause: Currant borers. As spring growth begins, you can easily spot borer-infested canes because the leaves look weak and sickly. Currant borers spend the winter in canes, pupate in the spring, and emerge as moths to reinfect currant bushes. The easiest control is to cut out and destroy infested canes as soon as you notice them.

Leaves spotted, yellow, and drop early. Causes: Septoria leaf spot; anthracnose. Since both of these fungal diseases overwinter on old leaf litter, rake up the leaves or bury them under a thick mulch in autumn. Copper sprays also control both diseases. If defoliation occurs late in the season, it does plants little harm.

Leaves with rust-colored pustules on undersides. Cause: White pine blister rust. This fungal disease is passed back and forth between white pines (or other 5-needled pines) and various species of *Ribes.* The disease is much more devastating to pines than to *Ribes,* so *Ribes* plantings are sometimes banned where pines are economically important. European black currants are most susceptible. Red and white currants generally are not much affected. Avoid planting susceptible currants near white pines.

Leaves with white powdery coating. Cause: Powdery mildew. Usually this fungal disease is harmless, but if it becomes severe, spray plants with sulfur, lime-sulfur, or a solution of sodium carbonate (washing soda) or sodium bicarbonate (baking soda).

Fruit colors and drops early. Cause: Currant fruit fly larvae. For more information, see "Fruit colors and drops early" on page 107.

Foliage stripped from bushes just as leaves expand. Cause: Imported currantworms. For controls, see "Foliage stripped from bushes just as leaves expand" on page 108.

Copyrighted material

D

Dahlia

Dahlia. Tuberous roots.

Descended from species native to Central and South America, modern dahlia hybrids are most often grown as annuals in temperate climates and are dug, overwintered indoors, and replanted the following spring. Thousands of cultivars offer a huge array of flower shapes, colors, and sizes to gardeners willing to meet dahlias' rigorous growth requirements. Thick-stemmed, rather coarse-textured plants range from 1′ to 8′ tall; midsummer to fall blossoms may be 1″-15″ in diameter.

Select a planting site in full sun and prepare the soil to a depth of 1′, incorporating plenty of compost or other organic matter. Dahlias require good drainage; raised beds help meet this need. Plant tuberous roots after all danger of frost has passed; placing them horizontally in the soil with the buds upward and fleshy roots spread out in the planting hole, 6″-8″ below the soil surface. Cover the buds with about 3″ of soil at planting, then gradually fill in as the shoots grow. All but the shortest cultivars need support for heavy flower heads. Set stakes at planting time.

Pinching shoots back during the growing season promotes bushier growth and increased flowering; removal of some buds increases the size of the remaining flowers. These heavy feeders benefit from side-dressings of compost or general-purpose fertilizer throughout the summer. Avoid high-nitrogen fertilizers, which encourage weak growth and pest and disease problems. Dahlias need at least 1″ of water weekly; soil should be neither soggy nor completely dry. Mulch to retain moisture.

Dahlias survive winter outdoors in Zones 9-10, given good drainage; otherwise they must be dug and stored. Cut plants back to about 1′ and dig the roots in fall before the first frost. Shake away loose soil and lay roots in the sun to dry for several hours. After drying, remove the tops and store the roots in a cool, dark, dry place. Check roots at regular intervals to make sure they're not so dry that they shrivel up.

Problems

Leaves wilt; stems collapse. Cause: Borers. Both European corn borer and stalk borer caterpillars are long, thin, and striped and tunnel within dahlia stems and flower stalks, causing collapse. Inspection of damaged plants reveals small, round holes in stems. Remove and destroy infested stems; clean up debris where pests overwinter. If borers have been a problem in past years, spray BTK weekly in early summer before borers enter stems.

Leaves mottled white or yellow. Cause: Leafhoppers. Feeding by wedge-shaped leaf-

hoppers gives leaves a speckled appearance, followed by dry, brown blotches; foliage becomes distorted and falls off. In addition to feeding injury, leafhoppers can spread aster yellows and other diseases. Encourage natural predators such as bigeyed bugs and parasitic wasps. Spray leafhopper infestations with insecticidal soap first; if control is unsatisfactory, treat with a commercial neem or pyrethrin spray.

Leaves yellow-green or deformed; shoots spindly, stunted. Cause: Viral diseases. Several viruses infect dahlias, causing stunted growth and yellowed leaves with ring spots, mottling, and pale or dead areas. Aphids and leafhoppers spread viruses; control pests to limit infection. Dig and destroy dahlias showing symptoms.

Flowers and foliage with gray mold. Cause: Botrytis blight. During wet, cloudy weather, *Botrytis* fungi can cause flowers to turn brown and rot. Pick and destroy infected plant parts. If blight is a persistent problem, apply sprays of bordeaux mix.

Daphne

Daphne. Shrubs.

Daphnes are small evergreen or deciduous shrubs; most produce fragrant flowers. They are excellent foundation shrubs.

Daphnes are not the easiest plants to grow; there is considerable controversy as to their soil preferences. Furthermore, for no known reason, plants will occasionally die. Plant them in organically enriched soils in sun or light shade and be sparing of fertilizer and water. Spring planting as container-grown or balled-and-burlapped plants suits them best.

Daphnes are little troubled by insects. In warmer climates scales may be a problem; see "Leaves yellow; stems and leaves covered with small bumps" on page 237.

Delphinium

Delphinium, larkspur. Perennials.

Dense flower spikes of lavender, true blue, pink, and white make delphiniums summer garden showstoppers. Towering flower stalks range in height from 1½′ to 8′, depending on the cultivar. Large, lobed, and deeply toothed leaves cluster near the ground.

Soil for delphiniums must be high in organic matter, slightly alkaline, well-drained, and moist. Select a site protected from damaging winds, and provide stakes for brittle, hollow flower stems. These plants prefer full sun, but benefit from afternoon shade where summers are long and hot. Delphiniums need cool summers and may die during extended hot, humid periods. Even under favorable conditions, most plantings lose vigor and need renovation every 3-5 years.

Problems

Leaves, stems, and buds distorted, sticky; clusters of small insects. Cause: Aphids. See "Leaves, stems, and buds distorted, sticky; clusters of small insects" on page 177 for controls.

Leaves with tan or brown blotches or serpentine tunnels. Cause: Leafminers. For recommended controls, see "Leaves with tan or brown blotches or serpentine tunnels" on page 27.

Leaves with large, ragged holes. Cause: Slugs and snails. See "Leaves with large, ragged holes" on page 177 for control information.

Leaves covered with white powder. Cause: Powdery mildew. See "Leaves covered with

white powder" on page 177 for controls.

Stems exude sawdustlike material and break; leaves wilt. Cause: Borers. Long, thin, striped stalk and burdock borers make small holes in the base of delphinium stems as they enter to feed. Sawdustlike castings around the holes mark the presence of these moth larvae. Prevent borers by removing weeds and plant debris where eggs might overwinter; applications of BTK give control only if applied just as borers are entering plants. You can also control borers by slitting affected stalks lengthwise, removing the borers, and binding the stems together—a long task in a large planting.

Leaves stippled, reddish to yellow, with fine webbing. Cause: Spider mites. These 1/50" arachnids quickly disfigure ornamentals. Their feeding causes leaves to yellow, dry up, and die. Excessive feeding turns foliage almost white; fine webs cover leaves and growing tips. Mites target water-stressed plants in hot, dry weather; adequate watering guards against them. Hose down infested plants; a strong stream knocks mites off plants, but may damage brittle flower stalks. Introduce predatory mites (1,000 per 500 square feet); spray severe infestations with avermectins, citrus oils, insecticidal soap, neem, or pyrethrin.

Stems blacken at base; leaves wilt; plant falls over. Cause: Crown or root rots. Both fungi and bacteria cause crown and root rot of delphiniums. Plants may wilt suddenly or yellow and wilt slowly. Stems and roots may turn black; mold may appear. Poorly drained, overly wet soil promotes rot; choose well-drained sites and add organic matter to improve drainage. Avoid injury to crowns when digging near plants; keep winter mulch away from crowns. Remove and destroy infected plants; wash tools used around diseased plants. Solarize the soil before replanting.

Leaves with yellow, brown, or black spots. Cause: Fungi. Several fungi cause spots on leaves. As spots enlarge, entire leaves may wither. Remove and destroy infected foliage; space plants to encourage good air circulation; avoid wetting foliage when watering. Dig and destroy seriously infected plants. Keep garden free of debris, and cut plants to the ground at the end of the growing season. Apply preventive sulfur sprays if leaf spot is a serious problem.

Deutzia

Deutzia. Shrubs.

Deutzias are a group of low-growing, deciduous, spring-blooming shrubs of rounded form. They are excellent in the shrub border or massed as an informal hedge.

Deutzias tolerate virtually any soil in sun or very light shade. Set out in spring as bare-root, balled-and-burlapped, or container-grown plants. They bloom on the previous year's wood, so prune after blooming, cutting back the branches that have flowered.

While deutzias are relatively free of major insect problems, aphids may feed on the leaves. For controls, see "Leaves wrinkled and discolored" on page 235. Leafminers may occasionally damage the leaves; see "Leaves tunneled" on page 237.

Dianthus

Pink, carnation. Perennials.

Sprightly pinks bear fringed flowers in shades of pink, white, maroon, and red over tidy, gray-green grasslike leaves. *Dianthus* spp. range in height from 4" to 18" with spreads of

1'-2'; most bloom profusely from late spring through summer. Popular species include sweet William (*D. barbatus*), a short-lived perennial often grown as an annual, and mat-forming maiden pinks (*D. deltoides*).

Well-drained, average soil with neutral to slightly alkaline pH is best for pinks. Most prefer full sun, but tolerate light shade, especially where summer temperatures are high. Pinks may decline in the heat of summer; select heat-resistant cultivars for southern gardens. Avoid overwatering but don't let plants wilt from drought stress. Cut plants back at the end of the blooming season to encourage new growth. Rejuvenate plantings by dividing them every 2-3 years.

Problems

Leaves stippled, reddish to yellow, with fine webbing. Cause: Spider mites. These 1/50" arachnids quickly disfigure ornamentals. Their feeding on the undersides of foliage causes it to yellow, dry up, and die; excessive feeding turns foliage almost white, and fine webs cover leaves and growing tips. Mites seek out water-stressed plants in hot, dry weather; adequate watering helps prevent infestations. Hose down plants when symptoms first appear; a strong stream knocks mites off plants and may give sufficient control. Introduce predatory mites (1,000 per 500 square feet); spray severe infestations with avermectins, citrus oils, insecticidal soap, neem, or pyrethrin.

Leaves, stems, and buds distorted, sticky; clusters of small insects. Cause: Aphids. Also known as plant lice, tiny aphids damage plants by sucking sap from leaves, stems, and buds. In addition, aphids transmit viruses that can injure plants long after the pests are vanquished. Use a strong spray of water to knock aphids off plants, or apply insecticidal soap sprays. Encourage natural predators such as lady beetles and lacewings. Treat severe problems with a commercial neem spray or pyrethrin spray or dust.

Leaves and flowers greenish yellow, distorted; new growth spindly. Cause: Viruses. Several viruses may infect pinks, stunting growth and mottling and spotting foliage. Control aphids and leafhoppers that spread viruses; there is no cure for infected plants. Remove and destroy plants with viral symptoms; don't compost diseased materials.

Leaf surfaces pale; powdery orange spots beneath. Cause: Rust. This fungus sometimes bothers sweet Williams, deforming leaves and stems and causing early leaf drop. Its orange spots release fungal spores that spread via wind and rain. Avoid wetting foliage when watering and encourage good air circulation. In problem areas, apply wettable sulfur several weeks before rust normally appears. Remove infected plant parts; clear debris from the garden in the fall.

Plant wilts; stems rot at soil level. Cause: Fungal or bacterial rots. Pinks are susceptible to various diseases that cause plants to wilt suddenly or to rot at or below the soil surface. This is especially true of plants growing in wet or poorly drained soil or in crowded conditions. Prevent problems by planting in well-drained sites, and avoid overwatering and overcrowding; keep mulch away from stem bases. Remove and destroy infected plants; do not compost diseased materials. If the problem is serious, solarize the soil before replanting a site.

Dicentra

Bleeding heart. Perennials.

These graceful plants carry prolific stems of dainty, heart-shaped flowers. Common bleeding heart (*Dicentra spectabilis*) is a Japanese native with dangling, pink and white blooms in late spring to early summer; native fringed

bleeding heart (*D. eximia*) bears pink or white blossoms on 1′ spikes throughout the summer. Plants range from 1′ to 3′ in height and spread. Medium green leaves are fernlike.

Plant bleeding hearts in moist, rich, and well-drained soil under light shade. Plants tolerate full sun only where summers are cool. Avoid sites with standing water, an invitation to stem rot. Mark the spot where you plant bleeding heart's fleshy roots—common bleeding heart foliage may die back after blooming and all species disappear in winter. Plant bleeding heart roots 2′ apart and don't disturb them; roots are brittle and do not transplant or divide easily. Few pests or diseases pose serious trouble for well-grown bleeding hearts.

Problems

Stems blacken at base; leaves wilt; plant falls over. Causes: Wilts; stem rots. Many destructive fungi live in soil and will attack plants at soil level. Plants may wilt suddenly or yellow and wilt slowly. Stems and roots may turn black; mold may appear. Discolored, water-soaked lesions girdle stems; plants gradually die. Poorly drained, overly wet soil promotes wilt and rot; choose well-drained sites and add organic matter to improve drainage. Avoid overwatering and overcrowding; keep mulch away from the base of stems. Remove and destroy infected plants; wash tools used around diseased plants.

Digitalis

Foxglove. Perennials.

Common foxgloves (*Digitalis purpurea*) are actually biennials that self-sow so well that they function as perennials. Bell-like flowers in shades of purple, pink, and white cover 2′-5′ spires in late spring. Large, coarse, dark green leaves cluster near the plant's base. True perennial species are available, but their blooms are fewer and less showy than common foxglove's.

Foxgloves enjoy a shady site with rich, moist, well-drained, slightly acidic soil. Plants tolerate full sun, but favor cool weather and need shade in extreme summer heat. Water regularly to maintain soil moisture. Stake tall cultivars to support flower spikes; plant in a sheltered site. Remove foxgloves after they have set seed and self-sown next year's crop. Cutting flowers before they set seed promotes second-year blooms, but flowering is reduced the second year.

Problems

Leaves and/or flowers with holes. Cause: Japanese beetles. These pests can seriously damage foxglove foliage; see "Leaves and/or flowers with holes" on page 176 for control information.

Leaves covered with white powder. Cause: Powdery mildew. For information on controlling this common and troublesome fungal disease, see "Leaves covered with white powder" on page 177.

Leaves with large, ragged holes. Cause: Slugs and snails. Slugs and snails may hide below foxgloves' low, broad foliage. Limit them by removing faded leaves and plant debris. See "Leaves with large, ragged holes" on page 177 for more control information.

Leaves, stems, and buds distorted, sticky; clusters of small insects. Cause: Foxglove aphids. These pests feed on other plants but overwinter as eggs on foxgloves. Good gardening practices will slow the spread of foxglove aphids. Remove spent plants in fall to reduce aphid activity in following years. See "Leaves, stems, and buds distorted, sticky; clusters of small insects" on page 177 for controls.

bleeding heart (*D. eximia*) bears pink or white blossoms on 1′ spikes throughout the summer. Plants range from 1′ to 3′ in height and spread. Medium green leaves are fernlike.

Plant bleeding hearts in moist, rich, and well-drained soil under light shade. Plants tolerate full sun only where summers are cool. Avoid sites with standing water, an invitation to stem rot. Mark the spot where you plant bleeding heart's fleshy roots—common bleeding heart foliage may die back after blooming and all species disappear in winter. Plant bleeding heart roots 2′ apart and don't disturb them; roots are brittle and do not transplant or divide easily. Few pests or diseases pose serious trouble for well-grown bleeding hearts.

Problems

Stems blacken at base; leaves wilt; plant falls over. Causes: Wilts; stem rots. Many destructive fungi live in soil and will attack plants at soil level. Plants may wilt suddenly or yellow and wilt slowly. Stems and roots may turn black; mold may appear. Discolored, water-soaked lesions girdle stems; plants gradually die. Poorly drained, overly wet soil promotes wilt and rot; choose well-drained sites and add organic matter to improve drainage. Avoid overwatering and overcrowding; keep mulch away from the base of stems. Remove and destroy infected plants; wash tools used around diseased plants.

Digitalis

Foxglove. Perennials.

Common foxgloves (*Digitalis purpurea*) are actually biennials that self-sow so well that they function as perennials. Bell-like flowers in shades of purple, pink, and white cover 2′-5′ spires in late spring. Large, coarse, dark green leaves cluster near the plant's base. True perennial species are available, but their blooms are fewer and less showy than common foxglove's.

Foxgloves enjoy a shady site with rich, moist, well-drained, slightly acidic soil. Plants tolerate full sun, but favor cool weather and need shade in extreme summer heat. Water regularly to maintain soil moisture. Stake tall cultivars to support flower spikes; plant in a sheltered site. Remove foxgloves after they have set seed and self-sown next year's crop. Cutting flowers before they set seed promotes second-year blooms, but flowering is reduced the second year.

Problems

Leaves and/or flowers with holes. Cause: Japanese beetles. These pests can seriously damage foxglove foliage; see "Leaves and/or flowers with holes" on page 176 for control information.

Leaves covered with white powder. Cause: Powdery mildew. For information on controlling this common and troublesome fungal disease, see "Leaves covered with white powder" on page 177.

Leaves with large, ragged holes. Cause: Slugs and snails. Slugs and snails may hide below foxgloves' low, broad foliage. Limit them by removing faded leaves and plant debris. See "Leaves with large, ragged holes" on page 177 for more control information.

Leaves, stems, and buds distorted, sticky; clusters of small insects. Cause: Foxglove aphids. These pests feed on other plants but overwinter as eggs on foxgloves. Good gardening practices will slow the spread of foxglove aphids. Remove spent plants in fall to reduce aphid activity in following years. See "Leaves, stems, and buds distorted, sticky; clusters of small insects" on page 177 for controls.

Dill

Anethum graveolens (Umbelliferae)

Dill is an annual herb grown for its tangy leaves and seeds. Sow seed outdoors where the plants are to grow after the soil is warm. Dill prefers a site in full sun with rich, well-drained, moist soil and a pH between 5.0 and 8.0.

Dill is rarely troubled by pests or diseases. Virus-infected leaves are dwarfed and deformed and abnormally colored. Destroy infected plants and control leafhoppers as they spread viruses. Leaf blight causes dark spots with yellow edges. To control this fungal disease, spray plants with fish emulsion or in severe cases, with sulfur. See the Herbs entry beginning on page 116 for other possible problems.

E

Echinacea

Purple coneflower. Perennials.

Purple, daisylike petals surround the prickly, brown centers of purple coneflower's (*Echinacea purpurea*) 1″-4″ wide blossoms. Plants grow 3′-4′ tall and bloom from early summer until frost. The cone-shaped centers persist throughout the winter, providing interest after the petals have fallen. Pale coneflower (*E. pallida*) has creamy white petals.

These durable prairie natives like full sun, but endure poor soils and tolerate some drought once established. Shaded sites cause tall, spindly growth, as does excess fertilization. Pinch in spring to encourage sturdy, branching growth. Coneflowers are somewhat short-lived; divide clumps every 3 years or so to rejuvenate plantings, placing divisions 20″ apart. Plants also start easily from seeds, which need light to germinate.

Japanese beetles can quickly skeletonize the foliage of purple coneflowers. See "Leaves and/or flowers with holes" on page 176 for controls.

Eggplant

Solanum melongena var. *esculentum* (Solanaceae)

Eggplants are tender perennials that are grown as annuals in temperate regions for the firm-fleshed fruit. Fruit shapes range from long and thin to short and blocky and may be white, yellow, or dark purple. Harvest fruit at any size, preferably before seeds turn brown and harden.

Culture

Eggplants do best in full sun and well-drained, fertile soil with lots of organic matter. They prefer a pH between 6.0 and 6.8, but will tolerate a pH as low as 5.5. Eggplants need a high level of nitrogen and moderate levels of phosphorus and potassium. Have the soil tested and correct any deficiencies. They grow best at temperatures between 70° and 85°F, and poorly above 95° or below 65°F.

Eggplants need lots of water. Keep the soil evenly moist, and never let it dry out. They do well in mulched, raised beds with drip irrigation. Black plastic mulch is a good choice because it warms the soil.

Purchase stocky, insect- and disease-free plants, or start your own from seed indoors. Soaking seed in 122°F water for 30 minutes before planting can help reduce seed-borne diseases. (Be aware that this treatment can damage seed viability; for complete instructions, see page 422.) Eggplant seeds germinate best between 80° and 90°F. Once seedlings are up, they grow best at 70°F. Do not plant out before average daily temperatures have reached 65°-70°F. Protect transplants from wind, and water new transplants well with seaweed extract or compost tea to give them a good start. Spray plants with seaweed extract with 1 teaspoon of Epsom salts added per gallon when the first flowers open to improve fruit set.

Eggplants are susceptible to many of the same problems, pests, and diseases as tomatoes, including flower drop or misshapen fruit due to extreme temperatures, flea beetles, Colorado potato beetles, aphids, hornworms, mites, Verticillium and Fusarium wilts, tobacco mosaic virus, and anthracnose fruit rot. See the Tomato entry beginning on page 227 for symptoms, causes, and controls.

Prevent problems by planting tobacco mosaic virus-tolerant cultivars such as 'Black-nite', 'Classy Chassis', 'Dusky Hybrid', 'Epic', and 'Vernal'.

Problems

Leaves turn yellow, then brown. Cause: Lace bugs. Leaves eventually die. These flat, gray to brown, 1/10" long insects have lacelike wings and feed on the undersides of leaves. Treat plants with a commercial pyrethrin spray or dust if damage is severe. Prevent problems by covering plants with row cover until they flower.

Leaves with large holes. Cause: Blister beetles. These 3/4" long, elongated beetles have yellow and black stripes. Wear gloves to handpick, since these beetles secrete a substance that may cause blisters. Blister beetle larvae help control grasshoppers, so think twice before spraying to control them. Treat plants with a commercial pyrethrin spray or dust if damage is severe.

Leaves with light-centered, gray to brown spots; fruit with pale, sunken spots. Cause: Phomopsis blight. Stems may also develop dark areas. Fruit spots enlarge and run together, affected flesh is discolored and may rot and shrivel. Spray plants with copper if symptoms are present and if weather is wet or humid. Prevent problems by planting resistant cultivars like 'Florida Beauty' and 'Florida Market'.

Fruit with dry, brown chew marks. Cause: Colorado potato beetles. See "Leaves with large, ragged holes or leaves missing" on page 190 for description and controls.

Epimedium

Epimedium. Perennials.

These 6″-12″ tall, evergreen to semi-evergreen plants bear clusters of ¾″, yellow, white, or pink flowers in early spring. Compound leaves consist of 2″-3″ long, heart-shaped leaflets, tinged pink or red in spring and turning yellow or bronze in fall.

Epimediums are slow to establish, but can form a hardy groundcover for moist, partially shaded locations and will grow in sites where low soil fertility limits other perennials. Cut foliage low to the ground in early spring to keep it from hiding the flowers.

Like most groundcovers, epimediums offer a haven for slugs and snails. See "Leaves with large, ragged holes" on page 177 for controls.

Euonymus

Euonymus, spindle tree. Trees, shrubs, and vines.

Euonymus are evergreen or deciduous trees, shrubs, or vines, always with opposite leaves and generally with toothed leaves. Shrubby species are good for hedges or specimen plants; vining species are great as groundcovers or on walls.

Set euonymus out in spring or fall as balled-and-burlapped or container-grown plants. The plants are tolerant of sun or shade, but heavy shade may decrease fruiting.

Problems

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. Scale insects are the most common insect pests on euonymus plants. See the opposite page for an illustration of euonymus scale and its damage. For control measures, see "Leaves yellow; stems and leaves covered with small bumps" on page 237.

Trunk or roots with swollen, wartlike growths. Cause: Crown gall. For an illustration of this bacterial disease, see the opposite page. For controls, see "Trunk or roots with swollen, wartlike growths" on page 238.

Leaves wrinkled and discolored. Cause: Aphids. See "Leaves wrinkled and discolored" on page 235 for controls.

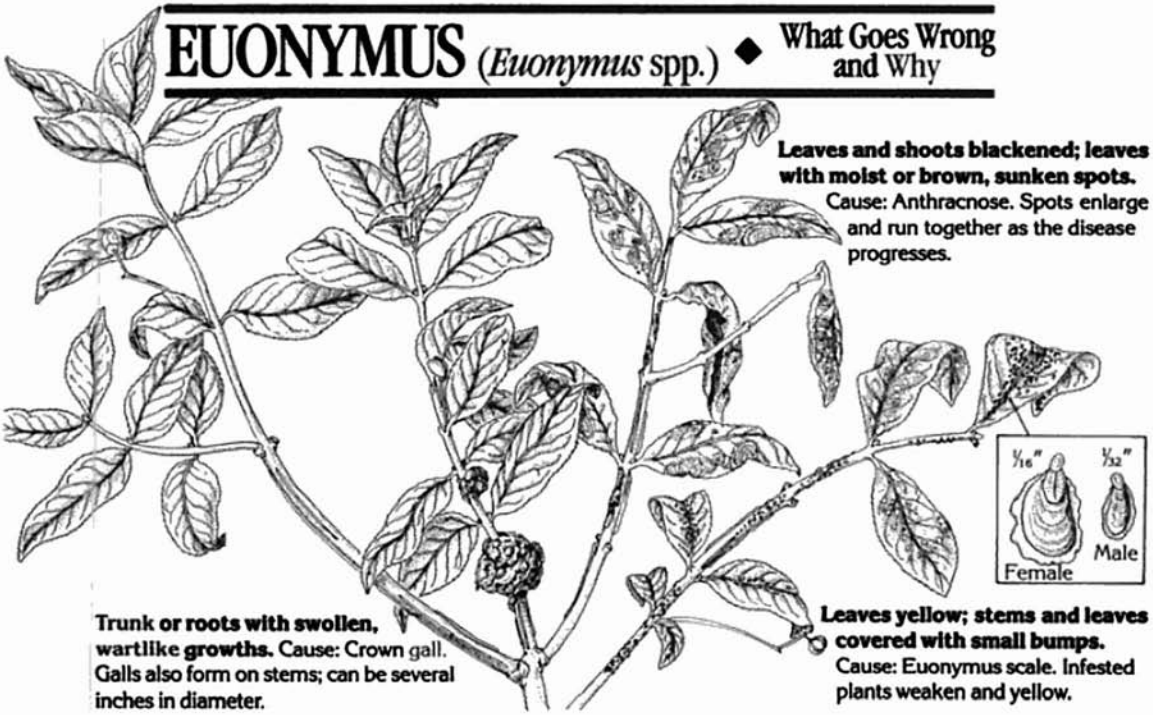
Leaves and shoots blackened; leaves with moist or brown sunken spots. Cause: Anthracnose. See the opposite page for an illustration of this disease. For control measures, see "Leaves and shoots blackened; leaves with moist or brown sunken spots" on page 238.

Leaves with powdery white coating. Cause: Powdery mildew. See "Leaves with powdery white coating" on page 237 for controls.

Euphorbia

Spurge. Perennials.

The species of perennial *Euphorbia* range in size from prostrate myrtle euphorbia (*E. myrsinites*) to 1′-1½′, clump-forming cushion

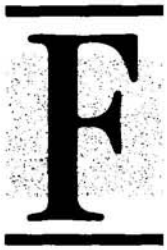

EUONYMUS (*Euonymus* spp.) ◆ What Goes Wrong and Why
Leaves and shoots blackened; leaves with moist or brown, sunken spots. Cause: Anthracnose. Spots enlarge and run together as the disease progresses.
1/16"
1/32"
Female
Male
Trunk or roots with swollen, wartlike growths. Cause: Crown gall. Galls also form on stems; can be several inches in diameter.
Leaves yellow; stems and leaves covered with small bumps. Cause: Euonymus scale. Infested plants weaken and yellow.

spurge (*E. epithymoides*) to 2'-3' tall Griffith's spurge (*E. griffithii*). Brightly colored flowers, actually showy bracts, bring shades of yellow and red-orange to the garden from early spring through summer, depending on the species. Plants remain attractive after bracts have faded; some offer red fall color. Also characteristic of this genus is milky sap that can cause skin irritation and burning; wear gloves when handling spurges and avoid contact with the sap.

Spurges prefer full sun and well-drained, moist soil, but may become invasive under these ideal conditions. In southern zones, they need partial shade during the heat of summer to prevent leggy, open growth. Spurges don't mind average to poor soil and most tolerate some drought. Divide vigorously growing plants every 2-3 years to check their spread, being sure to leave solid roots on each division.

Problems

Plant wilting. Cause: Lettuce root aphids. Usually sturdy and resistant to most pests, spurge is only occasionally infested by tiny white to yellow insects that feed underground on its roots as well as those of lettuce. Remove weeds to prevent aphids from multiplying in early spring. Add compost to soil to encourage beneficial nematodes, ground beetles, and other soil predators. Improve watering to help plants withstand root damage. In severe cases, drench the soil around spurges with neem.



Fagus

Beech. Trees.

Beeches are deciduous trees with gray bark and alternate leaves. They are one of the finest specimen trees for large landscapes. They do not, however, thrive on city conditions, and their spreading growth and extensive surface roots make it virtually impossible to grow other plants beneath them.

Set out balled-and-burlapped plants in spring in well-drained, evenly moist soil. Full sun is best but they'll tolerate part shade. Beeches are very sensitive to root zone disturbances—cuts, fills, compaction—so keep them safe from such abuse. A thick layer of organic mulch will protect the shallow roots and help keep them cool and moist.

Problems

Leaves skeletonized. Causes: Cankerworms; other caterpillars. Cankerworms are ½"-1", yellow, green, or brown caterpillars that feed on beech leaves, often defoliating the tree. To avoid this problem, apply a band of sticky coating, such as Tanglefoot, around the base of the tree in spring to keep females from climbing up and laying their eggs. Apply fresh coats in September and February to trap both spring and fall cankerworms. If their feeding becomes a problem, spray leaves with BTK as soon as you notice the pests; continue every 2 weeks until they are gone.

Several other caterpillars, including gypsy moths, loopers, and tent caterpillars, feed on beeches. See "Leaves skeletonized or with large holes; branches may be webbed" and "Plant defoliated" on page 236 for more information and controls.

Trunk or branches with small holes; limbs die or break off. Cause: Borers. See "Trunk or branches with small holes; limbs die or break off" on page 238 for controls.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. A number of scale insects attack beeches, including the white-colored beech scale. Note that beeches may be damaged by applications of dormant oil; instead, spray lime-sulfur on the trunk and branches in late winter. For other controls, see "Leaves yellow; stems and leaves covered with small bumps" on page 237.

Trunk or branches with oozing lesions; branch tips die back. Cause: Canker. Bleeding canker is spread by the beech scale, which feeds on the bark, causing wounds that permit entry of the fungus. Control the insect and you'll prevent the disease. For more details on dealing with canker, see "Trunk or branches with oozing lesions; branch tips die back" on page 238.

Leaves wrinkled and discolored. Cause: Aphids. See "Leaves wrinkled and discolored" on page 235 for controls.

Leaves with powdery white coating. Cause: Powdery mildew. See "Leaves with powdery white coating" on page 237 for controls.

Leaves with spots. Cause: Leaf spots. See "Leaves with spots" on page 237 for controls.

Fig

Ficus carica (Moraceae)

Figs are deciduous, subtropical trees or bushes that grow 10′-30′ tall and bear fruit on 1- and 2-year-old wood. They are hardy in Zones 8-10.

Fig trees need abundant sunlight but tolerate of a wide range of soil types. In colder areas, plant figs against a wall or wrap them for the winter to minimize dieback from cold. Each winter, head back long branches to maintain tree shape and induce vigorous new growth. Thin out crowded, weak, diseased, or crossed branches. Cultivars such as 'Celeste' and 'Mission', which fruit best on last year's wood, should be pruned more lightly than cultivars such as 'Magnolia' and 'Kadota', which fruit heavily on new growth. Some figs need cross-pollination; others develop fruit without pollination. Check pollination needs before buying plants.

Fruit Problems

Fruit soured, mushy, or smutty. Cause: Sour bugs. These small black beetles crawl into the eye of fruit and lay eggs that hatch into white grubs. The grubs carry bacteria that cause figs to turn sour, mushy, or smutty. Soured fruit may have a drop of pink, sticky fluid at its eye and a fermented odor. Smut produces dusty black spores. To prevent sour bug damage, grow closed-eye cultivars such as 'Brown Turkey', 'Celeste', 'Green Ischia', and 'Mission'. Clean up fallen fruit, which attracts beetles, and trap beetles in containers of fermenting fruit.

Fruit with ants inside. Cause: Insect feeding. Ants enter the fruit eye to feed on ripe fruit. To thwart ants, band stems with plastic or heavy paper coated with sticky material. Or place ant bait stations containing boric acid around trees. Wood ashes around the base of trees also helps prevent ants from climbing up to fruit.

Leaf and Branch Problems

Leaves with raised, rusty spots on undersides. Cause: Rust. Leaves may yellow and die. To control this fungal disease, rake up and destroy fallen leaves. Where the problem is severe, spray with copper.

Leaves spotted. Cause: Leaf blight. Various fungal diseases attack fig leaves and twigs. Control all these conditions by raking up and destroying fallen leaves and fruit. Also prune plants to remove infected twigs and allow sunlight to reach inner branches.

Whole Plant Problems

Whole plant lacking vigor; bumps on twigs and leaves. Causes: Scales; nematodes. Scales look like yellow, gray, white, or reddish or purplish brown bumps that you can scrape off stems or leaves with your fingernail. Many natural enemies, including lady beetles and chalcid wasps, help keep scales in check. Prune off heavily infested branches and destroy them. For serious infestations, spray before growth begins with dormant oil.

Nematodes are soil-dwelling, microscopic worms. Some nematodes perform helpful tasks, such as breaking down organic matter; others attack plant roots and cause diseaselike

symptoms. Figs grown in sandy soils are especially susceptible to nematode infestation. If you have sandy soil, plant your fig tree near a building and apply a thick, organic mulch. Both of these strategies seem to deter nematodes. If nematodes are common in your area, solarize the soil for 1 or 2 months during the summer before planting figs. Planting a cover crop of French dwarf marigolds or African marigolds or adding chitin to the soil also helps control nematodes. 'Celeste' and 'Hunt' are 2 nematode-resistant cultivars.

Filbert

Corylus avellana, C. americana
(Betulaceae)

Filberts grow as deciduous trees or shrubs reaching about 20'. They are hardy in Zones 4-8. To set nuts, most filbert cultivars need cross-pollination with a second cultivar.

Filberts blossom very early in the spring, so they need a site not prone to spring frosts. Plant in full sun. Since plants blossom on last year's wood, annual pruning is needed to stimulate current season's growth, which will bear next year's nuts.

Problems

Nut kernels blackened; nut shell has small hole. Cause: Filbertworms. These are the larvae of a brown moth. The easiest control is to keep trees free of ground debris, such as leaves, fallen nuts, and shells, because the larvae pupate on the ground throughout the winter.

New leaves twisted or curled and covered with a sticky coating. Cause: Aphids. Look on leaf undersides for clusters of these tiny black insects. Leaves also may be covered with a black fungus, called sooty mold, which feeds on honeydew secreted by these pests. For information on controlling aphids, see "New leaves twisted or curled and covered with a sticky coating" on page 67.

Flower buds swollen. Cause: Bud mites. Infected flowers don't produce nuts. Plant resistant cultivars, including 'Barcelona', 'Cosford', 'Italian Red', and 'Purple Aveline'. In severe cases, spray trees with superior oil around May when the mites crawl out of the swollen buds to attack healthy buds.

Branches blighted. Causes: Eastern filbert blight; western filbert blight. Eastern blight has no cure. It is present in the East and carried on American filberts. Young branches are destroyed first, then older branches and the trunk, without killing the roots. American filberts have some tolerance for the fungus, so they have been used in breeding with other filbert species in an attempt to create disease-resistant plants bearing high-quality nuts.

In the Pacific Northwest, blight is caused by western filbert blight, a bacterial disease. Small, angular spots appear on leaves, water-soaked at first, then turning reddish brown. Cankers form on branches, which then may die. Control this blight by preventing sunburn and winter injury, especially on young plants, which are most susceptible. On older plants, only smaller twigs die. Spray with copper and prune out infected twigs in winter.

Forsythia

Forsythia. Shrubs.

Forsythia is the most well-known spring-flowering, deciduous shrub. It is effective as a hedge, grouped for landscape accent, or in a shrub border.

Set out in spring or fall as bare-root or balled-and-burlapped plants. They require at least partial sun but flourish in almost any soil. Right after bloom, cut out some of the oldest canes to maintain strong flowering.

Forsythias are troubled little by insects. Crown gall may be a problem; see "Trunk or roots with swollen, wartlike growths" on page 238.

Fraxinus

Ash. Trees.

Ashes are deciduous trees with opposite, compound leaves that turn yellow to purple in the fall. Male and female flowers may appear on the same or different trees; all-male trees are preferred for landscaping since they don't produce undesirable seedlings. Ashes are used as street trees or specimens for large properties.

Set out trees in spring or fall. Full sun is best; the soil should be deep and moist but well-drained. Although often found growing along streams, ashes tolerate dry conditions and a range of soil pH. Vigorously growing ashes are fairly trouble-free.

Problems

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. Probably the most serious pests of ash are scale insects, with oystershell scale as the most important, especially in the Midwest. Putnam scale, San Jose scale, and soft scale (in warmer climates) also occur. For control information, see "Leaves yellow; stems and leaves covered with small bumps" on page 237.

Trunk or branches with small holes; limbs die or break off. Cause: Borers. See "Trunk or branches with small holes; limbs die or break off" on page 238 for controls.

Leaves skeletonized or with large holes; branches may be webbed. Cause: Caterpillars. For control information, see "Leaves skeletonized or with large holes; branches may be webbed" on page 236.

Branches with small masses of galls. Cause: Ash flower gall mites. These tiny mites attack male flower clusters on white ash (*Fraxinus americana*). Infested flowers develop abnormally, producing galls that dry and remain on the tree. Spray branches and galls with dormant oil in late winter for control.

Leaves with spots. Cause: Leaf spots. See "Leaves with spots" on page 237 for details.

Trunk or branches with oozing lesions; branch tips die back. Cause: Canker. See "Trunk or branches with oozing lesions; branch tips die back" on page 238 for controls.

Leaves distorted, orange-yellow spots on leaf undersides. Cause: Rust. This fungus produces orange pustules, distorting the leaves and making branch tips swell. Rust usually doesn't harm the tree much, except for detracting from the appearance. Clean up and destroy fallen leaves and branches in autumn. To prevent the spread of mild infections, spray leaves with sulfur early in the season.

Leaves skeletonized. Cause: Sawflies. See "Leaves skeletonized" on page 236 for controls.

Fritillaria

Fritillary. Bulbs.

Red, orange, or yellow, bell-shaped blooms hang downward in groups of 8-10 from crown imperial's (*Fritillaria imperialis*) 3′ tall flower stalks. Smaller checkered lilies (*F. meleagris*)

bear individual purplish flowers, marked with a checkerboard of dark purple on 1′ stems. Both the bulbs and the lance-shaped, dark green foliage have a musky odor that is reputed to discourage rodents.

Plant bulbs in early autumn as soon as they are available. Handle carefully to avoid bruising, and don't let them dry out before planting. Set bulbs 6″ deep in humus-rich, moist, very well drained soil under partial shade. Plants bloom in early spring; choose a site that offers protection from late frosts. Water during bloom. Well-grown fritillaries are troubled by few pests or diseases.

Fruit

Unlike vegetable crops, which share many of the same pests, fruit crops are affected by a wide variety of insects and diseases. Because fruit crops are borne on so many types of plants—including fruit trees, berry bushes, vines, and herbaceous plants such as strawberries—they have a wide range of cultural requirements as well. However, regardless of the crop you are growing, there are basic steps you can take to help prevent and control insects and diseases.

Site Selection

Full sun is a must for nearly all fruit crops: Even 1 or 2 hours of shade a day may result in smaller crops and less-flavorful fruit. Well-drained soil is also essential. In sites where drainage is a problem, plant in raised beds.

A location near the top of a gentle slope is ideal for fruit growing. A north-facing slope will help delay spring flowering, which is a plus in areas where frost damage is common. Planting about 15′ from the north side of a building also helps delay flowering. To help protect winter-tender trees, look for a sheltered site on the south side of a building.

Avoid planting in frost pockets where late spring frosts may damage blossoms and early fall freezes may shorten the harvest season. Frost pockets develop because cold air tends to sink and collects in depressions. Frost pockets occur at the bottom of valleys and on the uphill side of woods or buildings on slopes. If your whole property is a frost pocket, try training trees taller so they can blossom above the frost pocket, and try planting hardier cultivars.

While good air circulation helps reduce disease problems, blustery winds in open areas or on hilltops can make training difficult, knock fruit off trees early, or topple trees altogether. To encourage air movement, space plants far enough apart so they won't grow into each other or nearby plants.

Fruit Selection

Fruit trees and berry bushes are a long-term investment. Before you plant, learn about the types of fruit suitable to the local climate and soil type. Look for cultivars that will tolerate local conditions. Northern gardeners should choose cultivars that will survive winter cold, blossom late enough to escape late spring frosts, yet still set and mature fruit before the end of the growing season. Southern gardeners need cultivars that will tolerate intense summer heat and humidity and don't require much of a winter chilling period. If available, disease-resistant cultivars are desirable.

It's a good idea to consult nearby nurseries, botanical gardens, and fruit hobbyists—as well as local orchardists and extension agents—for information on growing fruit in your area. The more you know about local problems affecting fruits, the better your chances for selecting the right cultivars.

Almost all fruit trees and many grape vines are grafted onto a rootstock selected for strong rooting characteristics, disease resistance, or dwarfing effect. Many nurseries only offer 1 or 2 rootstocks that grow moderately well in a wide range of conditions. Some mail-order nurseries, however, offer a selection of rootstocks for the same fruit cultivars. Once you have identified a specific rootstock that should do well in your conditions, you may want to look for a source that carries it.

Some fruit trees come grafted on rootstocks that produce dwarf, semi-dwarf, and standard-size trees. Most home gardeners prefer dwarf or semi-dwarf trees, which fruit at a younger age than standard trees and are easier to tend.

Setting Fruit

When selecting fruit trees, it's important to understand their pollination requirements. Many fruit tree cultivars will only set fruit if the flowers receive pollen from a different but compatible cultivar. For example, 'Red Delicious' apples are self-unfruitful, meaning 'Red Delicious' trees can't pollinate one another, although they are good pollinators for other cultivars. On the other hand, 'Winesap' apples are not only self-unfruitful, they're also unable to pollinate other cultivars. To get fruit from a self-unfruitful plant, you need to plant another suitable cultivar for cross-pollination. 'Golden Delicious' is both self-pollinating (self-fruitful) and a good pollinator for other apples—including 'Winesap' and 'Red Delicious'.

Reputable nurseries will describe pollination requirements and suggest suitable pollinators. Most apples, pears, sweet cherries, and Japanese plums require cross-pollination to set a good crop. Most peaches, apricots, sour cherries, and some European plums are self-fruitful, although they often bear more heavily if cross-pollinated. Not all cultivars are compatible, so check with your supplier.

Planting

Proper planting will encourage healthy, vigorous plants that resist attack by insects and diseases. Choose your location and prepare the planting site before the plants arrive. Test the soil and amend as needed. Work lots of organic matter into the top 6″-8″ of soil, and remove all perennial weeds.

Most fruit plants are shipped bare-root and dormant. As soon as they arrive, inspect them for damage like broken roots or branches. Keep plants cool and the roots moist, but not wet, until you can plant them.

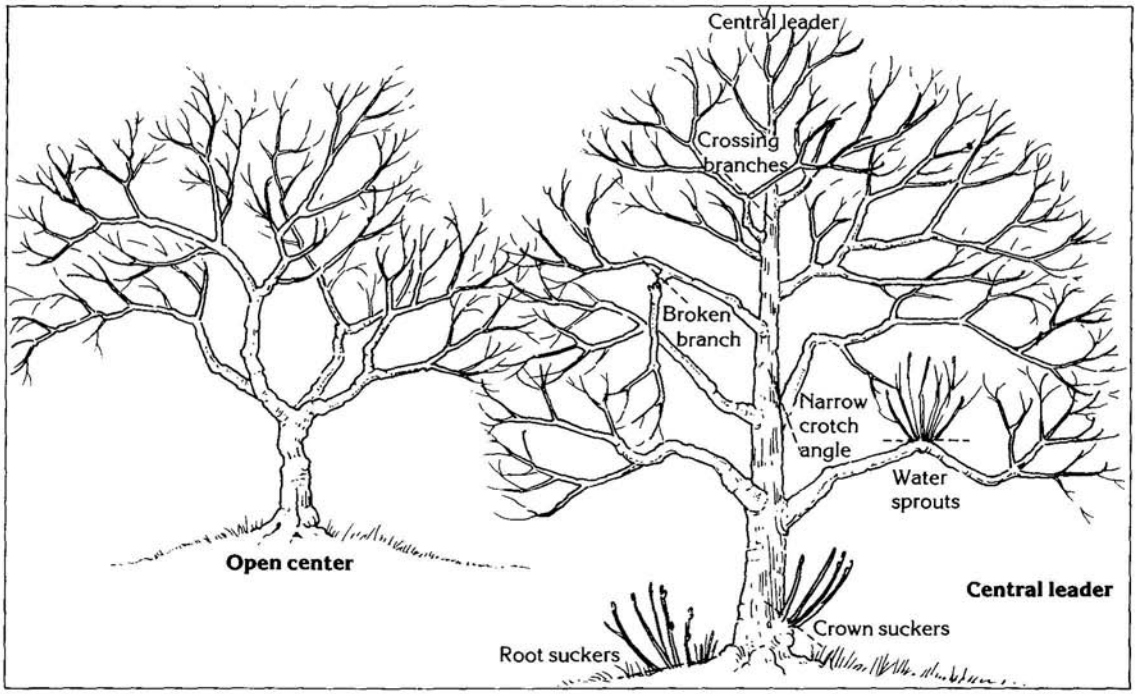
Dig a hole large enough in which to spread out the roots without cramping them. Cut back any damaged roots and shorten unusually long ones, if necessary. Most plants should be planted the same level at which they were growing in the nursery. Plant grafted trees with the graft union (which looks like an angle or an enlarged section near the base of the trunk) at least 1″ above the soil line. Exceptions to this rule may be noted in special instructions supplied with the plant.

Refill the hole with the soil you had removed, and water the plant well to give the plant a good start. Stake or trellis as needed to prevent damage, and reduce disease by encouraging good air circulation around the branches and between plants. Mulch to keep weeds under control, supply a slow release of organic matter, and conserve soil moisture.

Protect your new trees by painting the trunks with white latex paint diluted with an equal amount of water to prevent sunscald. Frustrate gnawing rodents by placing a 1′ high, ¼″ hardware cloth guard around the trunk, sunk into the soil 1″.

Pruning and Training

Fruit trees are pruned to develop strong branches, to remove dead or damaged growth, and to allow more air and sunlight into the



Open center (left) *and central leader* (right) *are 2 ways to train fruit trees to obtain maximum yield and exposure to sunlight. The best method depends on the growth habit of your fruit tree. In general, to improve tree health and performance, also remove any crossing branches, water sprouts, crown or root suckers, diseased or broken branches, or limbs that emerge at a narrow crotch angle.*

center of the plant to help prevent disease and insect problems. Pruning and training also help control size and encourage sturdy, well-spaced branches with wide crotch angles.

Start training trees as soon as they are planted. Prune off any damaged branches and any that are growing at a narrow angle to the trunk. Let the rest of the branches grow for a full year before starting to select your main branches.

It's important to establish sturdy, well-placed main branches while trees are young. Training can reduce the upward growth (affecting the amount of pruning you need to do) and will stimulate early fruit bearing. Train young branches to grow at a wide angle (about 45 degrees) by clamping a clip clothespin to the trunk just above each branch while they are still green and malleable. Older branches can also be spread, but with more difficulty. Use 1'-2' long boards with a notch in each end and brace them between the trunk and the

branch, or tie the branch to a weight (such as a rock) or the trunk. Gradually spread the branch during the season by moving the brace or tightening the string.

Prune apples, pears, grapes, and berries in late winter or early spring before they break dormancy. Prune peaches, plums, and cherries just after the buds burst in the spring, when they are less prone to canker infection. Remove dead and diseased branches on all kinds of fruit-bearing plants if they appear during the growing season. Summer pruning is also useful for controlling the growth of overly vigorous trees, as it stimulates less regrowth than dormant pruning does. Do not prune after August; fall pruning can increase the risk of winter injury.

There are 2 general types of pruning cuts: heading and thinning. Cutting a branch back partway to shorten it is a heading cut. Heading back a branch tends to encourage a flush of new shoots to sprout near the cut end. This is a useful technique for stimulating new branches when necessary, but too many heading cuts can cause overgrown, overly bushy trees. A thinning cut is used to remove a branch altogether by cutting it back to a main or side branch. Thinning encourages the remaining branch to grow, and unlike a heading cut, does not stimulate new ones to sprout. For this reason, thinning cuts are the best choice for developing an open framework and a sturdy, compact tree.

Fruit trees are usually trained and pruned into one of two general shapes: open center or central leader, which are illustrated on the opposite page. Modified central leader is intermediate between the two. The individual fruit tree entries include training recommendations. Grapes are usually trained on a trellis or arbor. Berry plants are thinned out in the appropriate season. There are a number of good references on page 493 that will give you complete, easy-to-follow instructions for pruning and training whatever type of fruit-bearing plants you choose.

Thinning

Fruit trees often set more fruit than they can ripen. Resulting fruit will be small and the excess weight can damage branches. Crowded fruit is also more susceptible to fungal diseases. Thin early in the season when fruit is as small as possible. First, clip or twist off all insect-damaged or deformed fruit. Then, remove the smaller fruit, leaving the biggest and best.

Space fruit so it will not touch each other as it grows. If you can't reach the upper limbs, tap them with a padded pole to shake loose some of the extras.

Preventive Care

Many disease and insect problems can be controlled or greatly reduced by simple sanitation. Clean up and dispose of branches after you prune, especially when removing diseased wood. Many insects pupate in the soil or in loose bark or dead plant debris. For this reason, rake and remove fallen leaves in fall. Also remove dropped fruit during the season and dry, diseased fruit (known as mummies) clinging to the branches after harvest. Inspecting bark in the winter and removing and destroying egg masses is also effective.

It's a good idea to find out what insects and diseases may attack your plants. Inspect plants regularly and control problems before they get out of hand. When problems do arise, start with the most environmentally gentle controls, such as handpicking, pruning, releasing predatory insects, or using mating disruption. Then move on to superior oil, insecticidal soap, BT, or sulfur. Use botanical pesticides, such as neem or pyrethrin, or copper compounds, only as a last resort after you have tried other less-toxic methods.

G

Garlic

Allium sativum and *A. ophioscorodon* (Liliaceae)

Garlic is a perennial herb grown for its pungent bulbs and greens. It is easy to grow healthy, trouble-free garlic. Plant cloves in the fall and cover with mulch after the weather turns cold. Garlic prefers full sun and rich, deep, moist, but well-drained soil with lots of organic matter and a pH between 6.0 and 7.0. Plants need extra water during summer while bulbs are forming. Water deeply when soil is dry. Once stalks begin to droop and brown at the end of summer, withhold water.

Garlic is closely related to onions and prone to the same problems, especially onion maggots. See the Onion entry beginning on page 155 for more information.

Geranium

Cranesbill. Perennials.

The cranesbills, *Geranium* spp., are hardy, easy-to-grow perennials that are often confused with the more tender zonal or bedding geraniums, which actually belong to the genus *Pelargonium*. Although related to the better-known zonal geraniums, cranesbills (also called hardy or true geraniums) are distinctly different from their tender relatives. Most have a mounding growth habit with spread roughly equal to height. Plants range from 4″ to 4′ tall with lobed to deeply divided foliage. Flowers bloom in spring and early summer in shades of pink, purple, red, and blue; many blossoms feature darker contrasting veins in petals or dark eyes. Some geraniums have a spreading growth habit; these are ideal for use as groundcovers.

Grow cranesbills in full sun to partial shade. Some species will grow in heavy shade, but, in general, too much shade reduces flowering and causes leggy growth. Plants tolerate some drought, but perform best in moist, well-drained soil of average fertility. Rich, moist soils encourage invasive growth in some species. Divide every 3-4 years in spring or fall. Some cranesbills form taproots that resist division: increase these types through root cuttings, stem cuttings, or seeds.

Hardy and fairly pest-free, cranesbills suffer few problems beyond those common to most perennials. Geranium aphids and four-lined plant bugs may attack them; see "Leaves. stems, and buds distorted, sticky; clusters of small insects" on page 177 and "Buds and leaves deformed or dwarfed" on page 178 for information on controls.

Gladiolus

Gladiolus, glad. Corms.

Showy, 2′-4′ tall glads brighten summer with tall spikes of trumpet-shaped, often bi-colored flowers. The 6-petaled blooms range from 2″ to 5″ wide and open from the bottom of the spike upward. Glads are upright plants with narrow, sword-shaped, 1′-1½′ long leaves. Hundreds of cultivars of common gladiolus (*Gladiolus* × *hortulanus*) offer gardeners a spectrum of flower colors and forms from which to choose.

Select and plant gladiolus corms in spring. Do not buy or use corms that are lightweight, spongy, or showing signs of decay. See the illustration on page 49 for more information. Good corms are about 1½″ wide with high tops. Large, healthy corms flower more quickly than smaller ones. Plant corms after danger of frost has passed. To create a succession of bloom, plant at 2-week intervals or plant different-size corms all at one time. Allow at least 3 months between planting and the first frost.

Prepare soil to 1′ deep in a sunny location. Add plenty of organic matter to ensure good drainage. Plant corms from 3″ to 8″ deep—about 4 times their thickness; space about 6″ apart. Make sure pointed growing tips face upward. Water regularly; glads need about 1″ of water per week. Mulch to help retain soil moisture. Side-dress with compost or slow-release, general-purpose fertilizer when plants emerge and when flowers show color. Plan to stake up the tall, flower-laden spikes; nearly all cultivars require some form of support.

In the South, gladiolus corms overwinter safely in the ground, but in most of the country they must be dug and stored indoors before hard frost. Allow leaves to die back naturally for about 6 weeks after flowering stops. After leaves and stalks turn brown, dig corms and shake off loose soil; cut away stems just above the top of the corms. Let corms dry out of the sun for a few days. Do not remove husks, as they help retain moisture. Discard withered old corms. Separate cormels, the tiny offspring surrounding a mature bulb, and store for planting—these bloom in 1-2 years. Check all corms for decay, spotting, or other disease symptoms. Dust with sulfur or copper-based fungicide to guard against disease problems; store in a cool (40°F), dry, well-ventilated place.

Problems

Flowers deformed; leaves and petals with white flecks. Cause: Thrips. Gladiolus thrips are a very destructive common pest. These 1/25″, yellow to black, flying insects feed by rasping petals and leaf surfaces, leaving silvery spots and streaks. They hide under leaf sheaths and inside flowers. Other symptoms are partial bloom, failure to bloom, and shriveling. Thrips' wastes may appear as black spots on the undersides of leaves. Infested corms are dark, sticky, and rough.

Cut away and destroy severely infested plant parts. Use blue sticky traps to monitor and trap pests. Encourage native predators such as pirate bugs, lacewings, and lady beetles. Insecticidal soap sprays give some control of thrips populations, but may affect beneficials as well. To limit thrips infestation, dig corms early in fall and cut off tops before thrips move down into corms. Bag and discard debris. Dust corms with pyrethrin to control thrips in storage. Or soak them in a Lysol solution (1½ tablespoons in 1 gallon water) for several hours before planting.

Leaves, stems, and buds distorted, sticky; clusters of small insects. Cause: Aphids. Plants infested with aphids have growth that may be curled, puckered, or stunted. Leaves may turn

yellow or brown; feeding can seriously damage flower buds or blooms. As aphids feed, they excrete sticky honeydew; black, sooty mold fungus often forms on honeydew, further disfiguring plants.

Use a strong spray of water in the morning to knock aphids off glads, paying particular attention to the undersides of leaves. Encourage predators such as lacewings and lady beetles. If control is not satisfactory, spray with insecticidal soap. Treat severe problems with neem or a commercial pyrethrin spray or dust. Destroy seriously infested plants.

Leaves yellow, distorted; flowers absent; corms decayed. Cause: Bulb mites. These 1/50", whitish pests favor damaged, rotting corms, but travel from those to healthy ones. Feeding causes corky, brown spots on corms, which eventually turn dry and crumbly. Dig and destroy seriously infested corms and the surrounding soil. Don't replant corms in infested soil. Kill mites by dipping corms in hot (120°F) water for a few minutes. Examine corms carefully when purchasing. For hints on choosing healthy bulbs, see the illustration on page 49.

Leaves yellow; plant dies early. Cause: Dry rot. Other symptoms of this fungal disease include dry, brown or black, corky spots on corms and husk coverings. You may see black fungal growth spots on decayed leaf bases. Plants may turn yellow and die prematurely. Choose corms carefully to avoid infected specimens. Destroy infected plants. Do not replant in same area. Replant only in well-drained soil.

Leaves mottled yellow and distorted; flowers small and faded. Cause: Fusarium yellows. This soilborne fungal disease is first seen as bending and curling of leaves and stems; foliage yellows and dies, starting with the oldest leaves. On corms small reddish brown lesions enlarge and darken; entire corms may become hard, dry, and mummified. Immediately destroy infected corms. Do not replant corms in same area. Some cultivars are more resistant than others; check with a reputable nursery or call your local extension agent for area-specific recommendations.

Leaves stippled and pale; growth poor. Cause: Spider mites. Mites feeding on leaves remove plant nutrients; fine webbing may appear on foliage. Use strong sprays of water when first symptoms appear. Mites multiply quickly and prefer drought-stressed, dusty plants. Keep gladiolus well-watered and healthy. Treat severe infestations of spider mites with avermectins, citrus oils, insecticidal soap, neem, or pyrethrin. Remove and destroy badly infested plants.

Stems eaten through at base. Cause: Wireworms. These click beetle larvae are common in soils formerly covered by sod or with high organic content. These slender, hard-bodied, yellowish worms drill holes in corms as they feed, damaging them and hastening decay. Set out traps made from buried pieces of raw potato or carrot; check every 1-2 days and destroy wireworms; replace traps as necessary. Delay planting corms until the soil is very warm; apply parasitic nematodes to soil to reduce wireworm populations.

Flowers, leaves, and stalks spotted; corms rotted. Cause: Botrytis blight. This fungal disease also causes slimy, collapsed leaves and flowers. It is most prevalent in cool, damp weather. Prevention includes planting gladiolus in areas with good air circulation. Avoid low or shaded areas. Water so leaves dry before sunset. Remove all debris at the end of the season and destroy.

Leaves with reddish brown spots; corms with pale to brown spots. Cause: Scab. This bacterial disease also causes brown spots on blossoms; plants rot at the base and fall over. Spots on corms turn dark brown with sunken centers and scabby margins. Dig and destroy infested plants; do not replant corms in infested soil.

Gleditsia

Honey locust. Trees.

Honey locusts are deciduous trees with alternate, fine-textured leaves. They cast dappled shade and, except for their thorniness and messy pods, are excellent as specimen or street trees. Thornless, nonfruiting cultivars are preferable. *Gleditsia triacanthos* var. *inermis* is thornless honey locust, from which most cultivars have been selected for landscape use.

Set out in spring or fall as bare-root or balled-and-burlapped plants. Honey locusts are undemanding and are well-suited to city conditions. While they prefer moist, fertile, slightly alkaline soil, they tolerate drought and salt.

Problems

Leaves skeletonized or with large holes; branches may be webbed. Cause: Caterpillars. Webworms can be a serious problem on honey locust. Some cultivars, such as 'Moraine', show some resistance to webworm damage. For other control information, see "Leaves skeletonized or with large holes; branches may be webbed" on page 236. Gypsy moths also feed on leaves, but they don't form webs. See "Plant defoliated" on page 236 for controls.

Plant defoliated; branches bear cocoonlike bags. Cause: Bagworms. See "Plant defoliated; branches bear cocoonlike bags" on page 236 for control suggestions.

Trunk or branches with small holes; limbs die or break off. Cause: Borers. See "Trunk or branches with small holes; limbs die or break off" on page 238 for controls.

Trunk or branches with oozing lesions; branch tips die back. Cause: Canker. For details, see "Trunk or branches with oozing lesions; branch tips die back" on page 238.

Gooseberry

Ribes hirtellum, R. uva-crispa
(Saxifragaceae)

Gooseberries are thorny bushes with arched branches growing 3'-5'. The inconspicuous flowers are borne laterally on 1-year-old wood and on short spurs—short branches that elongate only a fraction of an inch per year—on older wood. Gooseberries are hardy in Zones 3-8.

In cool climates plant gooseberries in full sun. Choose partial shade in hot climates. Maintain a thick, organic mulch beneath plants to keep soil cool and moist. Prune mature plants every winter, cutting away all but 6 of the shoots that grew the previous season at ground level. Also remove all wood more than 3 years old. Gooseberries are self-pollinating.

Fruit Problems

Fruit with powdery white or gray coating. Cause: American gooseberry mildew. This fungal disease spreads most rapidly during periods of warm days followed by cool nights. Under these conditions the crop can be ruined overnight. For more information, see "Leaves with powdery white patches; leaves stunted and deformed" below.

Fruit with holes when nearly ripe; fruit and leaves covered with webs. Cause: Gooseberry fruitworms. These are the yellow-green larvae of a moth that infests both gooseberries and currants. Damaged fruit may be hollowed out and may change color prematurely. Clean up and destroy damaged fruit to reduce future populations.

Fruit colors and drops early. Cause: Currant fruit fly larvae. The currant fruit fly lays eggs on gooseberries and currants in the spring. The larvae that hatch from these eggs feed on

berries and cause them to drop. Infested berries have a dark spot surrounded by a red halo. Early-bearing cultivars, such as 'Oregon Champion' and 'Welcome', may escape damage. Control this pest by destroying all infested berries as soon as you find them.

Leaf Problems

Leaves with powdery white patches; leaves stunted and deformed. Cause: American gooseberry mildew. To prevent this fungal disease, avoid overfertilizing plants. Lush, sappy growth is more susceptible to infection. Plants well-supplied with potassium are best able to resist mildew. For serious infection, spray plants with lime-sulfur. Or spray a solution made from 1 pound of washing soda (sodium carbonate) plus ¼ pound of soap in 1 gallon of water. Don't spray sulfur on the cultivars 'Bedford Yellow', 'Langley Gage', and 'Leveller'; these are easily damaged by sulfur. Cultivars resistant to gooseberry mildew include 'Hinnomaki Yellow', 'Lepaa Red', 'Poorman', and 'Welcome'.

Leaves with spots; leaves yellow and drop. Causes: Septoria leaf spot; anthracnose. Since both these fungal diseases overwinter on leaf litter, rake up leaves or bury them under a thick mulch. Copper sprays also control both diseases. If defoliation occurs late in the season, it does little harm.

Foliage stripped from bushes just as leaves expand. Cause: Imported currantworms. These are the larvae of a sawfly that lays eggs on gooseberry bushes. The larvae devour the leaves, then drop to the ground to pupate. Control with a commercial pyrethrin spray. Make sure to spray into the center of the bush. Controlling of the first brood may eliminate the need for another spray.

Leaves blistered and reddened. Cause: Aphids. These tiny insects cluster on leaf undersides. If damage is severe, spray with insecticidal soap, neem, or pyrethrin, making sure to get the undersides of the leaves.

Grape

Vitis spp. and hybrids (Vitaceae)

Grapes, one of the most ancient cultivated crops, are perennial, woody vines that cling to support by means of tendrils. Under ideal conditions vines may live for over 100 years. Fruit is produced on shoots that grow off 1-year-old wood.

There are 4 main types of grapes grown in North America: European, or wine grapes (*Vitis vinifera*); American (*V. labrusca*), such as 'Concord'; hybrids between European and American; and muscadine (*V. rotundifolia*). European grapes generally are most susceptible to diseases. American grapes are the most cold-hardy. Their hardiness (Zones 4-10) depends on the species and cultivar.

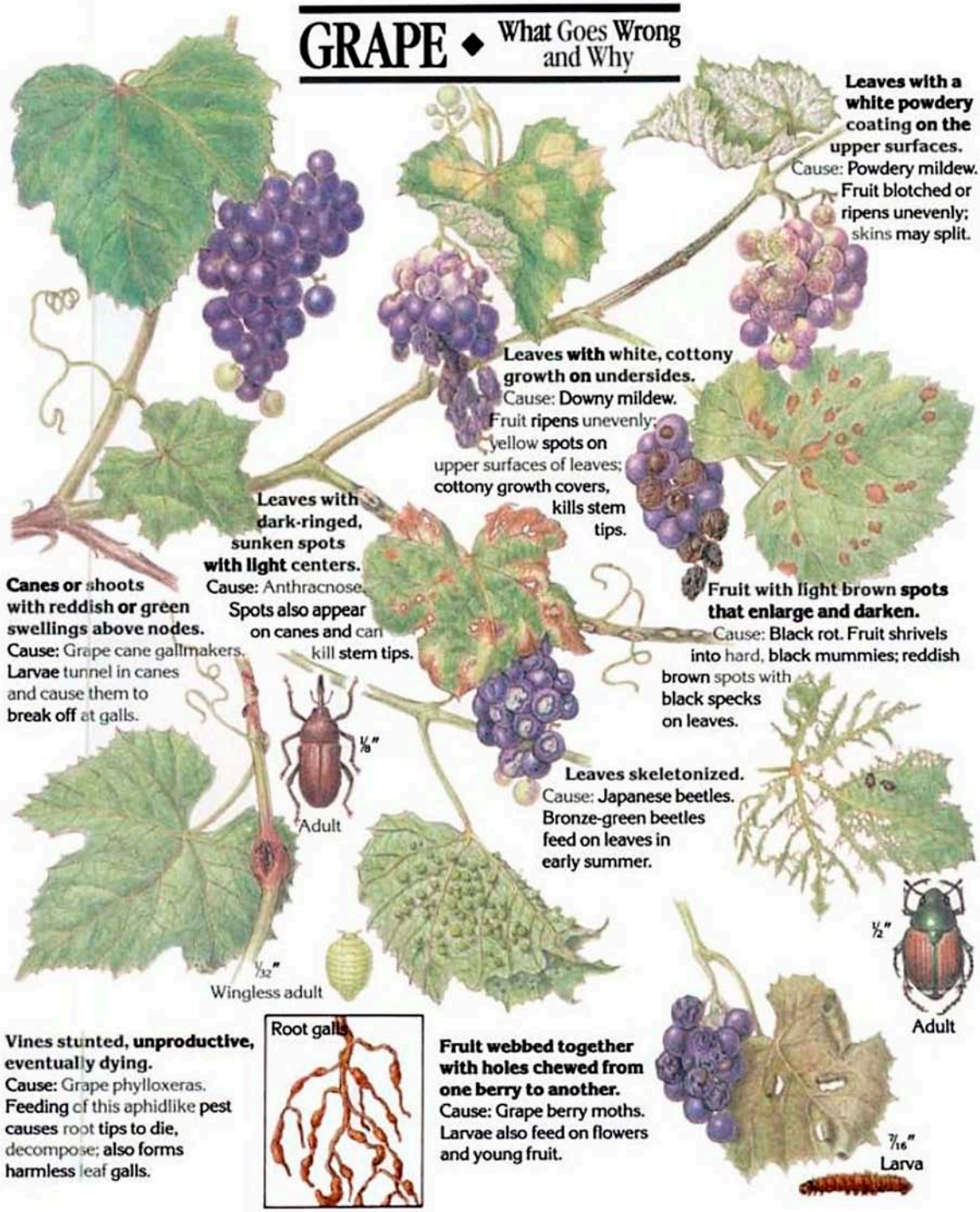
Culture

Plant in a sunny site with deep, well-drained, moderately fertile soil and good air circulation to promote disease resistance. Train vines to a fence or trellis. Prune in late winter to keep the fruit within reach, to increase cluster size, and to allow air and sunlight to penetrate the branches. Enclose fruit clusters in paper bags to keep birds away from berries and to control some insects and diseases. Many muscadines need cross-pollination, but the other types are self-pollinating.

Fruit Problems

Young fruit covered with a white coating; fruit ripens unevenly or covered with blotches. Causes: Powdery mildew; downy mildew. Early in the season, fruit infected with powdery mildew has a white, dustlike coating on the berries. Infected plants may set few berries. Later on, the infection can halt the growth of

GRAPE ◆ What Goes Wrong and Why


Leaves with a white powdery coating on the upper surfaces.
Cause: Powdery mildew. Fruit blotched or ripens unevenly; skins may split.
Leaves with white, cottony growth on undersides.
Cause: Downy mildew. Fruit ripens unevenly; yellow spots on upper surfaces of leaves; cottony growth covers, kills stem tips.
Leaves with dark-ringed, sunken spots with light centers.
Cause: Anthracnose. Spots also appear on canes and can kill stem tips.
Canes or shoots with reddish or green swellings above nodes.
Cause: Grape cane gallmakers. Larvae tunnel in canes and cause them to break off at galls.
Fruit with light brown spots that enlarge and darken.
Cause: Black rot. Fruit shrivels into hard, black mummies; reddish brown spots with black specks on leaves.
1/8"
Adult
Leaves skeletonized.
Cause: Japanese beetles. Bronze-green beetles feed on leaves in early summer.
1/32"
Wingless adult
1/2"
Adult
Vines stunted, unproductive, eventually dying.
Cause: Grape phylloxeras. Feeding of this aphidlike pest causes root tips to die, decompose; also forms harmless leaf galls.
Root galls
Fruit webbed together with holes chewed from one berry to another.
Cause: Grape berry moths. Larvae also feed on flowers and young fruit.
7/16"
Larva

the berry skins, causing them to split while green. Ripened clusters have blotchy, poor-tasting fruit, but have no white growth.

Ripening fruit clusters infected with downy mildew may have a mix of hard, reddish green, infected berries and soft, juicy, healthy berries. The fuzzy coating on fruit apparent early in the season may not be present. For information on controls for these diseases, see "Leaves with a white powdery coating on the upper surfaces" below for powdery mildew symptoms; for downy mildew, see "Leaves with white, cottony growth on undersides" below.

Fruit with light brown spots that enlarge and darken. Cause: Black rot. Common east of the Rockies, especially in hot, humid weather, black rot causes fruit to shrivel into hard, black shriveled berries (known as mummies) that remain on the cluster. Overwintering mummies and infected canes or shoots carry the disease from one growing season to the next. For control, remove and destroy all mummies. For persistent infection, apply copper sprays. Cultivars moderately resistant to black rot include 'Beta', 'Campbell's Early', 'Cascade', 'Chancellor', 'De Chaunac', 'Delaware', 'Elvira', 'Fredonia', 'Hunt', 'Ives', 'James', 'Scuppernong', 'Sheridan', and 'Worden'. See page 109 for an illustration of this disease.

Fruit with small, dark-ringed, sunken spots with light centers. Cause: Anthracnose. For more information on this disease, also called bird's-eye rot, see "Leaves with dark-ringed, sunken spots with light centers" below.

Fruit clusters enveloped with a fluffy, gray-brown coating. Cause: Botrytis bunch rot. This fungal disease appears in tight fruit clusters and in vines with poor air circulation. For prevention, thin berries within clusters and remove some leaves around fruit. Clean up prunings, cluster stems, and mummified fruit by early spring. Plant resistant cultivars, including 'Baco No.1', 'Cascade', 'Catawba', 'Concord', 'Delaware', 'De Chaunac', 'Fredonia', 'Ives', and 'Niagara'.

When the timing of this infection is perfect, it imparts a special taste to European wine grapes. In this case it is called "noble rot," for the taste it imparts to wine.

Fruit webbed together with holes chewed from one berry to another. Cause: Grape berry moths. This pest, common east of the Rockies, is a green or brown, 7/16" caterpillar that moves from fruit to fruit, feeding on pulp and seeds. Pick and destroy infested berries, which shrivel and color prematurely. Larvae also feed on flowers and newly set fruit. Larvae cut flaps in the edges of leaves and roll them over with webbing to pupate. At the end of the season, collect and destroy or bury fallen leaves, which may harbor overwintering pupae. For heavy infestations, spray BTK to kill the caterpillars. See page 109 for an illustration of this pest.

Fruit covered with a sticky coating and black mold. Causes: Grape whiteflies; grape mealybugs. Whiteflies and mealybugs secrete a sticky coating, called honeydew; sooty mold, a black superficial fungus, feeds on the honeydew. Both whiteflies and mealybugs are serious grape pests in California.

To control whiteflies, remove nearby buckthorns (*Rhamnus* spp.), where the pest overwinters. Or spray nearby buckthorns in the winter with dormant oil spray.

Natural enemies usually keep mealybugs in check, but for heavy infestations, introduce mealybug destroyers (*Cryptolaemus* spp.), also called Australian lady beetles. Buy these natural predators from commercial insectaries or natural farm and garden suppliers. Also, ants protect mealybugs from predators and feed on their honeydew. To make mealybugs more susceptible to predators, control ants by placing bait stations containing boric acid on the ground around vines.

Fruit with holes. Cause: Birds. Birds peck

holes in ripening berries and are especially fond of red or blue cultivars. Damaged fruit attracts bees and wasps for further feeding. Drape a net over the whole vine or bag individual clusters in paper bags.

Leaf and Branch Problems

Leaves with a white powdery coating on the upper surfaces. Cause: Powdery mildew. Infected leaves eventually become distorted, turn brown, and fall. Dark patches appear on canes. This fungal disease weakens vines, diminishes yield, and makes plants more susceptible to winter injury. More common in the West, it spreads fastest when days are dry and warm and nights are cool. For susceptible plantings, apply sulfur spray in the spring. Plant resistant cultivars, including 'Canadice', 'Cayuga White', 'Ives', and 'Steuben'. See page 109 for an illustration of this disease.

Leaves with white, cottony growth on undersides. Cause: Downy mildew. Other symptoms of this fungal disease include small yellow leaf spots, distorted or brown leaves, and early leaf drop. Older leaves are affected first, but the disease also attacks shoots and tendrils. To control downy mildew, remove and destroy all diseased leaves and tendrils in the fall. Since the fungus overwinters on bud scales and shoots, you may have to spray vines with copper several times throughout the growing season to control the disease. Do not spray copper during flowering. Plant resistant cultivars, including 'Aurora', 'Baco No.1', 'Canadice', 'Cascade', 'Concord', 'Foch', 'Himrod', and 'Steuben'. See page 109 for an illustration of this disease.

Leaves with dark-ringed, sunken spots with light centers. Cause: Anthracnose. Also called bird's-eye rot, this fungal disease weakens but usually doesn't kill vines. For control, remove and destroy diseased portions, including infected berries, and spray in the spring with lime-sulfur. Muscadine grapes and the American cultivars 'Concord', 'Delaware', 'Moore Early', and 'Niagara' are anthracnose-resistant. See page 109 for an illustration of this disease.

Leaves with reddish brown spots with black specks. Cause: Black rot. Leaves may wilt and shoots may show large, black, elliptical lesions. For more information, see "Fruit with light brown spots that enlarge and darken" above.

Leaves or leaf petioles with reddish swellings. Cause: Grapevine tomato gall. The ½" swellings are galls made by a very small fly called a midge. If you slit one of the galls open, you may find small pinkish orange maggots inside. These galls are harmless. Just prune them off.

Leaves with green, pealike swellings on undersides. Cause: Grape phylloxeras. Phylloxeras are aphids that make leaf galls to hold eggs and young. Inside 1 gall, you may find hundreds of yellowish nymphs. Grape phylloxeras are native to the United States and are tolerated by American grapes, but they're serious pests of European grapes. In fact, when phylloxeras were accidentally transported to France in the late 1800s, they spread rapidly through vineyards and killed almost a third of the grapevines there. To avoid problems with phylloxeras, plant American or French hybrid grapes, both of which are resistant to this pest. Phylloxeras also attack roots of susceptible species, causing death of the whole vine. See page 109 for an illustration of this pest.

Leaves with pale stipples along leaf veins. Cause: Leafhoppers. These green or brown, 1/10"-½" insects suck juices from leaf undersides, causing foliage to be stippled with tiny white spots. Heavily infested leaves may turn yellow or brown and drop from the vine. Though they are quite common, leafhoppers rarely cause serious damage to backyard grapes. Many natural enemies keep them in check. Where

further control is needed, spray leaves with insecticidal soap.

Leaves skeletonized. Cause: Japanese beetles. These ½", metallic blue-green insects with bronze wing covers feed on leaves in early summer. For light infestations, visit plants in the morning while beetles are sluggish and knock them off leaves into jars filled with soapy water. For more information, see "Leaves skeletonized" on page 46. See page 109 for an illustration of this pest.

Canes or shoots break easily. Cause: Grape cane girdlers. This ⅛" beetle punctures a cane, lays a single egg inside, and then encircles the cane with 2 rows of punctures. Damaged canes or shoots then break off easily. Damage is usually minor, but to control this pest, remove and destroy the injured cane a few inches below the area with puncture marks.

Canes or shoots with reddish or green swellings above nodes. Cause: Grape cane gallmakers. This ⅛" beetle deposits a single egg in a cane and then makes additional punctures in a vertical row above the original egg-laying site. The area where the egg is deposited enlarges to a red or green gall about twice the diameter of the cane. Larvae tunnel in canes, and canes often break off at the galls. Damage is usually minor, but to control this pest, remove and destroy the injured cane a few inches below the gall. See page 109 for an illustration of this pest.

Whole Plant Problems

Vines stunted, unproductive, eventually dying. Causes: Grape phylloxeras; grape scale; Pierce's disease. Grape phylloxeras are aphids that infest both leaves and roots. Leaf infestation causes harmless, pealike leaf galls. Root infestation causes knotlike root galls that prevent nutrient uptake and cause stunting and death of the vine.

Phylloxeras are difficult to eradicate. Where they are a problem, plant American grapes or European grapes grafted onto American grape rootstock, both of which are resistant to this pest. For more information on grape phylloxeras, see "Leaves with green, pealike swellings on undersides" on page 111. Also see page 109 for an illustration of this pest.

Grape scales are tiny, round, immobile insects resembling light gray bumps. Scales usually hide under the loose bark of older canes or trunks, where they suck sap and cause the vine to slowly decline. For control, spray with dormant oil in late winter and prune old growth severely.

Pierce's disease, a bacterial disease common in the South, is spread by leafhoppers. Infected vines typically show scorched, dried leaves in midsummer, wilted dried fruit, and eventual death of the vine. There is no cure for this disease. Dig up infected plants and replant with disease-free stock. Muscadine grapes are resistant to Pierce's disease, as are the American grape cultivars 'Champanel', 'Herbemont', and 'Lenoir'.

Gypsophila

Baby's-breath, gypsophila. Perennials.

The delicate white or pink flower sprays of baby's-breath (*Gypsophila paniculata*) are a mainstay of floral arrangements. Sprays may have more than 1,000 single or double flowers, each just 1/16" wide. This mounding plant is equally delightful in the garden where it grows 2'-3' tall and 2' wide, bearing copious blooms over slender, gray-green leaves. Creeping baby's-breath (*G. repens*) forms a blossom-covered

mat only 4″-8″ tall and is useful for edging or rock gardens.

Plant baby's-breaths in sites where they won't be disturbed or moved; their large fleshy roots do not transplant well. Given full sun, alkaline soil, and good drainage, plants thrive with little care. Remove spent flowers to prolong bloom. Protect plants with winter mulch; don't cover crowns until after the ground is frozen to avoid rotting.

Problems

Leaves stippled; growth poor. Cause: Leafhoppers. Slender, wedge-shaped, greenish yellow pests only ⅛″ long, aster leafhoppers suck sap from the undersides of leaves as they feed, discoloring and distorting the foliage. Damaged leaves shrivel and drop. Encourage predators such as bigeyed bugs and parasitic wasps, or spray with insecticidal soap. In severe cases treat plants with a commercial neem or pyrethrin spray.

Leaves and flowers greenish yellow, distorted; new growth spindly. Cause: Aster yellows. Feeding leafhoppers may transmit this disease. There is no control for aster yellows. Remove and destroy infected plants; do not compost them. Prevent the disease spread by controlling sucking pests such as leafhoppers and aphids.

H

Hamamelis

Witch hazel. Shrubs and small trees.

Witch hazels are alternate-leaved shrubs with narrow-petaled, twisted, yellow or coppery flowers appearing either in late fall or late winter. They flourish in well-drained but moisture-retentive soils, enriched with lots of organic matter.

Witch hazels are relatively free of serious insect pests. Caterpillars and Japanese beetles may cause some damage; see "Leaves skeletonized or with large holes; branches may be webbed" and "Leaves skeletonized" on page 236 for controls. Witch hazel cone gall, which appears as a conical gall on the upper leaf surfaces, is caused by a kind of aphid, as are elliptical galls on the flower buds. Neither is usually a major problem; control both by repeated applications of insecticidal soap in late spring, early summer, and autumn.

Hedera

Ivy. Vines.

Ivies are vigorous evergreen vines, climbing by means of rootlike appendages. They are widely planted as groundcovers, as vines on walls, or as houseplants.

Set out bare-root plants in spring or fall. Almost any moisture-retentive soil will suit ivy. In the North, strong winter sun can scorch leaves; it's best to choose a site where some shade is available. Cut back in late winter to promote denser growth.

Problems

Leaves wrinkled and discolored. Cause: Aphids. For controls, see "Leaves wrinkled and discolored" on page 235.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. See "Leaves yellow; stems and leaves covered with small bumps" on page 237 for control information.

Leaves stippled with yellow; foliage webbed. Cause: Spider mites. See "Leaves stippled with yellow; foliage webbed" on page 236 for controls.

Leaves with circular brown spots. Cause: Bacterial leaf spot. This bacteria can cause water-soaked spots on lower leaves. These spots turn brownish black and may spread to form large patches of dead tissue. To prevent the spread of this disease, avoid working around wet plants. Remove and destroy affected parts; spray bordeaux mix on remaining plants.

Trunk or branches with oozing lesions; branch tips die back. Cause: Canker. See "Trunk or branches with oozing lesions; branch tips die back" on page 238 for controls.

Leaves with powdery white coating. Cause: Powdery mildew. For controls, see "Leaves with powdery white coating" on page 237.

Helianthus

Sunflower. Annuals.

Rapid growth, showy flowers, and tasty seeds make sunflowers fun to grow as well as nutritious. The plants can grow to 10′ tall. Individual flowers may reach 14″ across, with golden petals and a brown center that becomes a mass of seeds by late summer.

Sunflowers need warmth to germinate. Direct-sow seeds ½″ deep in average soil in early May. They will germinate within 10 days. Space tall-growing cultivars 2′ apart, or they will crowd each other. Sunflowers perform well in average soil and full sun, although they will tolerate light shade. Apply a general-purpose fertilizer once, about midway through the growing season.

Problems

Leaves, stems, and buds distorted. Cause: Aphids. For control measures, see "Leaves, stems, and buds distorted" on page 20.

Leaves with ragged holes. Cause: Caterpillars. Caterpillars of all kinds find large sunflower leaves a tasty food supply. A healthy plant can generally withstand an attack. Handpick pests, or spray leaves with BTK.

Leaves wilt. Causes: Lack of water; fungal wilt. If a good soaking does not perk up your plant by the next day, suspect a fungal wilt. These fungi live in the soil and move upward through the plant. Leaves may be mottled with green and yellow, and dark brown areas may appear on and within sunflower stems. There is no control; remove and destroy infected plants. Avoid replanting sunflowers in that area.

Leaves with powdery white patches. Cause: Powdery mildew. For controls, see "Leaves with powdery white patches" on page 19.

Helichrysum

Strawflower. Annuals.

These 1½'-3' Australian natives are best known as an integral part of dried flower arrangements. If picked when partially opened, strawflowers hold their color well and last for several years indoors. Colors include white, yellow, salmon, red, and pink.

Sow seeds indoors 6-8 weeks before the last outdoor frost. Do not cover seeds; they need light during the 7-10 day germination period. Transplant seedlings 9"-12" apart. Where summers are long, direct-sow strawflowers in late spring or early summer. Plant in full sun in well-drained, moderately fertile, slightly moist soil. They are fairly drought-tolerant once established. Taller cultivars may need staking. Little fertilizer is needed; too much fertilizer results in many leaves and few flowers. Pests and diseases are rarely a problem.

Helleborus

Hellebore. Perennials.

Hellebores flower in winter and early spring, earning names such as Christmas rose (*Helleborus niger*) or Lenten rose (*H. orientalis*). Most have green, creamy white, or dull purple blooms, carried over low evergreen foliage.

Plant in partial shade, such as that found under deciduous trees, in moist, well-drained, neutral soil rich in organic matter. Maintain even soil moisture with a summer mulch. The brittle rhizomes make this plant difficult to divide or transplant; if you must move them, do so with care. Dark brown to black leaf spots, yellowing leaves, and stem cankers indicate fungal infection; to prevent, spray with bordeaux mix or sulfur.

Hemerocallis

Daylily. Perennials.

Favored for their ability to thrive under tough conditions, daylilies grace many urban plantings. There are thousands of hybrids from which to choose. Plants range in height from 1½' to 3' and offer blossoms in every color but true white and blue. A mature planting provides hundreds of 2"-6", trumpet-shaped flowers and graceful, swordlike, bright green leaves. Each flower lasts a day, then closes at night, but numerous buds provide extended periods of bloom.

Daylilies are easy-to-grow, nearly problem-free plants that perform best in full sun. Most also tolerate partial shade; in fact, plants may grow better in some shade in southern zones. Plant in well-drained, average soil and water regularly to get the plants established. After that, limited watering is fine, but don't let them dry out while blooming. Excess fertility encourages lush foliage and fewer flowers. Plants grow vigorously if undisturbed; clumps expand over time but are usually not invasive. Remove spent flower stalks to prolong bloom. In fall, cut all stems to the ground and remove dead foliage. Divide large clumps every 3-5 years. Roots are tough, heavy, and tuberous, so this is not an easy job. Leave a crown bud and several solid roots on each division.

Problems

Flower buds die; stems have corky lesions. Cause: Flower thrips. These 1/25" insects occasionally infest daylilies, feeding on buds, stem

tips, and flowers. Infested plants have distorted blooms, and in severe cases, flower stalks fail to develop. Stems may develop corky lesions that extend several inches. Thrips are difficult to control because they burrow into plant tissue. Use blue sticky traps to monitor populations and trap pests. Pick off and destroy infested plant parts, and encourage natural predators such as pirate bugs, lacewings, and lady beetles. Regular sprays of insecticidal soap may give some control once pests are spotted on traps.

Leaves stippled, reddish to yellow, with fine webbing. Cause: Spider mites. These 1/50" arachnids feed on the undersides of leaves, causing them to yellow, dry up, and die; excessive feeding turns foliage almost white, and fine webs cover leaves and growing tips. Mites seek out water-stressed plants in hot, dry weather; adequate watering guards against them. Hose off plants when symptoms first appear; a strong stream knocks mites off plants and may give control. Introduce predatory mites. Spray severe infestations of spider mites with avermectins, citrus oils, insecticidal soap, neem, or pyrethrin.

Herbs

Herbs are grown for their savory, aromatic, or medicinal parts. They include annuals, biennials, and perennials. In general, herbs are little troubled by pests and diseases if given good growing conditions.

To grow healthy, trouble-free plants, choose a well-drained site with as much sun as possible. Most do not need rich soil, and some actually prefer dry, poor soil; check individual entries for specific preferences.

Whole Plant Problems

Seedlings fall over; stems girdled or rotted at soil line. Cause: Damping-off. This disease is caused by soil-dwelling fungi. To prevent it, disinfect reused pots and flats before filling them with fresh seed-starting mix. To disinfect, dip them in a 10 percent bleach solution (1 part bleach to 9 parts water) and let them air-dry. Sow seed thinly to allow for air movement around seedlings. Cover seed with a thin layer of soilless mix or vermiculite. Water only enough to keep soil moist, not soggy.

Seedlings clipped off at soil line. Cause: Cutworms. Check for fat, 1" long, brown or gray caterpillars in the soil near the base of plants. Once they chew a seedling in two, there is nothing you can do except protect the remaining seedlings from their nocturnal attacks. Place cutworm collars around transplants, sprinkle moist bran mixed with BTK on the soil surface in the evening, or add parasitic nematodes to the soil to control.

Plant yellow and stunted, wilts during bright, hot days; roots have swollen galls. Cause: Root knot nematodes. These microscopic, wormlike creatures invade and feed on plant roots. Pull and destroy infected plants. Control pest nematodes by adding chitin or parasitic nematodes to the soil. Solarizing problem areas also reduces future problems.

Plant wilts; cut-open roots are discolored. Cause: Verticillium or Fusarium wilt. There is no cure for these diseases. They are caused by a number of fungi, each of which attack only specific plants or plant families. Pull and destroy infected plants. Avoid planting susceptible members of the same plant family for 3 or more years in soil where disease symptoms have developed.

Leaf Problems

Leaves turn yellow, older ones first; plant stunted. Cause: Nitrogen deficiency. This may be caused by a low level of nitrogen in the soil

or by waterlogged soil. Waterlogged soil damages roots and prevents them from using nutrients available in the soil. Check soil moisture, and reduce watering if soil is soggy. Spray foliage with compost tea or fish-meal tea, or side-dress plants with compost to alleviate symptoms. Prevent problems by choosing well-drained sites, adding organic matter to the soil to add nitrogen and improve drainage, and by planting in raised beds.

Leaves yellow and curled; new growth distorted. Cause: Aphids. These small, soft-bodied, green, black, gray, pink, or white fluffy-coated insects suck plant juices. They leave a sticky honeydew on leaves and fruit that in turn supports the growth of black, sooty molds. Spray with a strong jet of water or insecticidal soap if populations are low. If populations are high, treat with a commercial neem or pyrethrin spray.

Leaves yellow; plant wilts; stems, crowns, or roots water-soaked and rotted. Cause: Stem, crown, or root rot. These diseases are often due to poor drainage or overwatering. Destroy infected plants or plant parts. Thin plants to increase air movement and reduce moisture around plants. Spray with a copper fungicide if weather is warm and wet and disease is severe. Plant in well-drained soil or in raised beds.

Texas root rot occurs in warm climates and is favored by high temperatures and a pH above 7.0. If pH is high, add sulfur to the soil to lower it. Use a 3-year rotation to starve the fungus out of the soil.

Leaves with dark, yellow-bordered spots. Cause: Leaf blight. This disease is caused by various fungi. Leaves may turn yellow or drop off as the disease progresses. Spray foliage with fish emulsion or with sulfur to prevent the spread of mild infections.

Lower leaves covered with tan, fuzzy growth. Cause: Gray mold. This fungal disease attacks a wide range of edible and ornamental plants. Pick off and destroy moldy leaves. Thin plants to increase air movement and reduce moisture around leaves, since the mold thrives in damp conditions. Spray foliage with compost tea to control mold. Spray with sulfur if the weather is wet and cool and the disease is severe.

Leaves with powdery white growth on upper surface. Cause: Powdery mildew. This symptom is caused by a number of fungi, each of which attacks only specific plants. Thin plants to increase air movement and reduce moisture around leaves. Spray plants with compost tea, sulfur, or bordeaux mix to prevent the spread of mild infections.

Heuchera

Alumroot, coral bells. Perennials.

Although no other species in this genus compares with the dainty blossoms of coral bells (*Heuchera sanguinea*), several are worthy additions to the perennial border. Low-growing clumps of rounded, lobed, heart-shaped, or maplelike foliage are usually evergreen and interesting throughout most of the year. Cultivars of American alumroot (*H. americana*) and small-flowered alumroot (*H. micrantha*), both grown more for foliage than flowers, offer leaves with purple coloring.

Plant alumroots in well-drained, richly organic soil in a sunny or lightly shaded spot. Partial shade is best for foliage and for plants in the South. Shallow, fleshy roots need regular watering and benefit from summer mulching; however, excess moisture, combined with poor drainage, promotes rots.

Problems

Leaves covered with white powder. Cause: Powdery mildew. Powdery mildew may mar

foliage and is best limited through sanitation and air circulation. See "Leaves covered with white powder" on page 177 for controls.

Crowns blacken and die; leaves notched. Cause: Strawberry root weevils. The grubs of ¼", black snout beetles feed on alumroots' crowns starting in early spring. Adults feed at night on foliage. Remove and destroy infested plants; clean up debris where pests overwinter. Drench soil around roots with parasitic nematodes; spray pyrethrin on leaves at night to kill adults.

Hibiscus

Hibiscus, rose-of-Sharon.
Shrubs and trees.

These old-time favorites have bushy but upright habits and bloom in mid- to late summer. They are easy to grow, even withstanding seashore conditions. Avoid unwanted volunteer seedlings by planting sterile cultivars.

Set out in spring or fall as bare-root or container-grown plants. They prefer full sun and average soil with added organic matter.

Hibiscus are fairly problem-free. Aphids or Japanese beetles may feed on foliage; see "Leaves wrinkled and discolored" on page 235 and "Leaves skeletonized" on page 236.

Hosta

Hosta, plantain lily. Perennials.

Grown primarily for their attractive, 5"-10", broadly lance-shaped leaves and durability as groundcovers, hostas are unparalleled perennials for shady areas. Handsome ribbed leaves may be short and narrow or broad and up to 1½' long; leaf colors range from light to dark green or blue-green and may be variegated with yellow, light green, cream, or white. Spikes of tubular, 2", white to purple flowers show nicely above foliage from mid- to late summer.

Hostas look their best in light to deep shade. Sunny sites encourage flowering but also cause foliage color to bleach and brown and sunburned spots to appear on leaves. Set plants 1'-3' apart, depending on leaf size, in moist but well-drained, organic soil. Give plants ½"-1" of water weekly; mulch to avoid splattering water onto leaves.

Hostas may be increased by division, although plantings will prosper undisturbed for many years. If desired, divide plants every 5 years or so. Remove faded flower stalks to improve appearance, and cut back foliage at the end of the growing season.

All hostas go dormant in winter. New leaves emerge in spring. Try not to select heavily puckered leaf forms for use under trees. The puckers or wrinkle designs catch leaf drippings, including gum and sap, which detract from the plants' appearance.

Problems

Leaves small, light brown, papery, scorched, or bleached. Causes: Lack of water; too much sun. An easy way to ruin hostas is to let them dry out, even for a little while. Even if they continue to grow, plants will be stunted. Sunburned edges or spots reduce hostas ornamental value significantly and are best avoided through proper selection of planting site.

Leaves with large, ragged holes. Cause: Slugs and snails. Hostas' broad, low-growing foliage welcomes these slimy pests. See "Leaves with large, ragged holes" on page 177 for controls.

Stems blacken at base; leaves yellow and wilt; plant collapses. Cause: Crown rot. Hostas are susceptible to fungal and bacterial attack when grown in poorly drained soil. Crown

injury and excess moisture during dormancy also increase the chances of infection. Choose well-drained sites; add organic matter to improve soil drainage; keep winter mulch away from crowns. Remove and discard infected plants and the surrounding soil.

Houseplants

The world of houseplants covers a vast array of plant species from all over the world. And any enthusiast's collection may include species native to a wide variety of climates, from tropical jungle-dwellers, such as some orchids or philodendrons, to desert-dwelling cacti. Despite the diverse cultural requirements different houseplants prefer, there are basic techniques that will ensure healthy plants that resist pests and diseases.

Culture

Since houseplants live in an artificial environment, maintaining pest- and disease-free plants requires attention to 4 main areas of care: light, temperature, humidity, and water. As with plants grown outdoors, healthy houseplants are less susceptible to attack by pests and diseases. Plants stressed by light exposure, temperature extremes, improper watering, or low humidity are more prone to problems than those provided with conditions that meet their basic requirements.

Unless you own an artificial lighting system especially for houseplants, choose plants with light needs similar to the natural light in your home. Too little light on a sun-loving plant causes pale leaves and leggy growth. Too much sun on a plant that prefers low light causes leaf scorch, yellowing, and dehydration. North-facing windows provide indirect sun and the lowest light level; they're also often the coolest exposures. East- and west-facing windows provide moderate amounts of bright light; west-facing windows, which receive hot afternoon sun, tend to be warmer than east-facing ones. South-facing windows provide the brightest and longest-lasting light and also the most heat. Keep in mind that overhanging awnings, drapes, or nearby trees affect the amount of light plants receive.

As a general rule, plants grow best at daytime temperatures of 60°-80°F and nighttime temperatures of 58°-65°F. Avoid wide temperature swings; keep plants away from heat vents, radiators, air-intake ducts, and air-conditioning vents.

Low humidity is a familiar problem to indoor gardeners. During the heating season, indoor humidity may only be 10 percent. Most tropical species require 40-60 percent humidity to thrive. The easiest way to increase humidity is to run a whole-house or portable humidifier. Not quite as efficient, but still worthwhile, is the practice of keeping a pan of water near a heat source. Grouping plants together also improves indoor humidity because leaf transpiration from a cluster of plants increases the air moisture in the immediate area. To further humidify a plant grouping, set plants on trays filled with 1" of pebbles and ½" of water.

Most houseplants should be watered only when the soil is dry. Test soil dryness by digging your finger an inch into the soil. Water only if this soil is dry to the touch. Don't allow excess water to stand in saucers, and avoid wetting foliage. Improper watering may cause wilting that can be mistaken for diseases.

Plants growing in a commercial potting mix need little additional fertilizer if repotted regularly. During active growth in spring and summer, most plants benefit from regular doses of a liquid organic fertilizer such as fish emulsion; mix and apply according to label directions. Fertilize less during the winter, when lower temperatures and light levels slow the

growth of most plants.

To catch problems before they become serious, it's a good idea to inspect plants regularly for signs of insects or diseases. Rinsing the plant occasionally with room-temperature water in the sink or bathtub is also a good idea: It rinses away insects along with dust that can inhibit photosynthesis.

Problems

Leaves spotted, yellowed, browned, or wilted; roots, stems, or leaves with rotted spots. Cause: Cultural problems. Too much or too little water, persistent hot or cold drafts, improper light exposure, potbound roots, or nutrient starvation can all cause symptoms that can be mistaken for pests or diseases.

To diagnose cultural problems, review the conditions the plant prefers and examine the plant. Also consider the amount of light the plant receives, review watering patterns, and look for drafts or other problems that may not be immediately apparent. Once you've decided on a cause, correct the situation. See "Culture" on page 119 for more information.

Leaves and stems with white fuzzy growth that later turns brown. Cause: Powdery mildew. Cut out all diseased parts; place the plant in an area where it will receive excellent air circulation. If necessary, use a small fan to move air around the plant.

Leaves and stems with white cottony patches. Cause: Mealybugs. Isolate affected plants; dip a cotton swab in 70 percent isopropyl alcohol and wipe each insect. A few days later, rinse the plant in the shower, or outdoors (in shade) with a fine mist of water from a hose. Check for mealybugs again after a month and re-treat if necessary.

Leaves pale and discolored; tiny brown bumps on undersides and stems. Cause: Scales. These immobile insects suck fluids from plant cells. They may excrete sticky honeydew onto nearby leaves. Isolate affected plants. Remove heavily infested leaves. Gently scrape insects from stems with your fingernail; spray plants with insecticidal soap. (Don't use soap on ferns.) After a week, rinse plants in water. If the problem persists, wipe leaf undersides with a solution of 1 tablespoon vegetable oil in ¾ cup warm water.

Leaves pale or stippled with fine webbing on undersides. Cause: Spider mites. These spiderlike creatures, no larger than a speck of dust, suck juices from plant leaves. They spread most rapidly in hot, dry conditions. Isolate affected plants; ideally, move them to a more humid location. Remove heavily infested leaves and stems. Spray thoroughly with insecticidal soap (do not use soap on ferns), then mist with water daily for a week.

Leaves crinkled or curled with a sticky coating on undersides. Cause: Aphids. These tiny, sucking insects secrete a sugary honeydew that may attract ants. Isolate affected plants. Remove heavily infested leaves and stems. Wipe insects off stems with a cotton swab dipped in warm soapy water. Spray with insecticidal soap. (Do not use soap on ferns.)

Leaves with dark, sooty blotches. Cause: Sooty mold. This fungus lives on the honeydew excreted by aphids, mealybugs, and scales. Treat the plant for the insect infestation. Then clean the foliage with warm soapy water and rinse. See "Leaves and stems with white cottony patches," "Leaves pale and discolored; tiny brown bumps on undersides and stems," and "Leaves crinkled or curled with a sticky coating on undersides" above for information on controlling these insects.

Leaves, stems, or flowers with gray, moldy growth. Cause: Botrytis blight. This fungal disease thrives on plants that have been overwatered, overfed with nitrogen, or overcrowded. Remove and discard affected plant parts. If the plant has tender growth due to excess fertilizer, withhold feeding until current growth hardens off. Divide overgrown or crowded plants, improve air circulation, and withhold water until soil is nearly dry.

Hyacinthus

Hyacinth. Bulbs.

Cultivars of *Hyacinthus orientalis,* the only species in this genus, are prized for the heady aroma they bring to the spring garden. Tubular or bell-shaped blossoms cover dense, blunt, 10″-12″ tall, upright spikes; each bulb produces 1 spike of white, pink, blue, or yellow flowers. Narrow, straplike leaves surround the base of the stalk.

Plant bulbs in fall at least 1 month before the ground freezes. Select a site in full sun with humus-rich, well-drained soil; sheltering from wind reduces injury to rigid flower stalks. Set bulbs 4″-5″ deep with pointed growing tips facing upward. Hyacinths multiply less freely than other bulbs and flowering tends to diminish with age. Plant new bulbs every 2-3 years for optimal floral display. Remove spent flowers to prevent seed formation; let foliage die back naturally.

Problems

Leaves yellow or distorted; bulbs decayed. Cause: Bulb mites. Like most bulbs, hyacinths may be infested by bulb mites. See "Leaves yellow or distorted; bulbs decayed" on page 50 for controls.

Leaves and stems with spots, gray mold, or yellow slime; bulbs decayed; growth poor. Cause: Bacterial and fungal rots. Hyacinths are subject to a number of rot diseases. Rots are prevalent in poorly drained soil; control through careful bulb selection and culture. For tips on buying healthy bulbs, see the illustration on page 49.

Leaves with swollen spots; plant fails to grow. Cause: Bulb and stem nematodes. Tiny roundworms feed on bulbs; plants fail to grow in spring or fail to bloom. Swollen, yellow-green spots appear on leaves; an infested bulb, cut in half, reveals dark blotches or rings. Wet soil encourages nematodes. Dig and destroy infested bulbs; check new bulbs carefully for pests. Plant in well-drained soil.

Hydrangea

Hydrangea. Shrubs and vines.

Hydrangeas are opposite-leaved, deciduous shrubs and vines. The flowers are small but borne in large clusters. Hydrangeas are ideal for shrub borders or grouped for landscape interest.

Hydrangeas are among the few flowering shrubs that bloom well under shaded conditions, although they flourish in full sun in cooler climates. They prefer acid soils. Set out in spring or fall as balled-and-burlapped or container-grown plants.

Problems

Leaves wrinkled and discolored. Cause: Aphids. For control information, see "Leaves wrinkled and discolored" on page 235.

Leaves tied together over flower buds. Cause: Hydrangea leaftiers. The ½″, green-bodied, brown-headed caterpillar causes the foliage to become ragged, turn brown, and die. If the infestation is light, break open the "envelopes" and pick off the caterpillars; for heavier infestations, spray plants with BTK.

Leaves deformed; shoot tips blackened. Cause: Tarnished plant bugs. This pest is an active, ¼″, light green to brown bug mottled with white, yellow, red, and black. When it feeds on the leaves, it produces a toxin that deforms the leaves and blackens the terminal shoots and flowers. Tarnished plant bug overwinters on weeds and under leaves; removing these havens will greatly reduce the likelihood

of subsequent infestation. Control severe infestations by dusting leaves with pyrethrin.

Leaves with powdery white coating. Cause: Powdery mildew. See "Leaves with powdery white coating" on page 237 for controls.

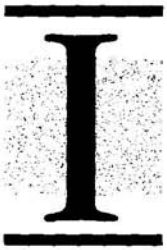
Flowers rot. Cause: Botrytis blight. In wet seasons, *Botrytis* fungi can cause a blight on hydrangeas that will spoil the flowers. Pick off and destroy affected blooms.

Leaves stippled with yellow; foliage webbed. Cause: Spider mites. See "Leaves stippled with yellow; foliage webbed" on page 236 for suggested controls.

Leaves and flowers skeletonized. Cause: Rose chafers. This ⅓", reddish brown beetle with thick, yellowish hairs on its wing covers appears in late spring and damages both leaves and flowers. Handpicking is the best control. Reduce populations of larvae by treating lawn areas with milky disease spores. Spray plants with pyrethrin as a last resort.

Leaves and flowers browned and wilted. Cause: Bacterial wilt. This disease can spread quickly, killing the plant in hot weather. Remove infected parts as soon as you see them; destroy seriously infected plants.

Leaves with small brown spots. Cause: Rust. Infected leaves have bright orange spots underneath and pale yellow spots on the upper surfaces; they eventually wilt and drop. Remove and destroy leaves infected with this fungal disease. As a last resort, spray or dust with sulfur, repeating as needed.



Iberis

Candytuft. Perennials.

These very hardy evergreen border plants brighten spring with clusters of tiny blossoms of pure or pink-tinged white. Evergreen candytuft (*Iberis sempervirens*) grows to about 1′ tall with a spread of 1½′-2′, while rock candytuft (*I. saxatilis*) is even more compact, reaching heights of 3″-6″. The 1½″-2″ inflorescences last several weeks.

Plant candytufts in full sun in well-drained soil. Light shade is tolerated but reduces flowering, as does drought. Cut plants back after flowering to encourage compact growth. Foliage may brown in cold, windy conditions: mulch lightly to reduce injury. Few pests or diseases trouble candytufts.

Ilex

Holly. Trees and shrubs.

Hollies are deciduous or evergreen trees or shrubs with alternate leaves. The male and female flowers are borne on different plants; female plants produce striking red or black fruit. Hollies are useful as foundation shrubs, accent plants, informal hedges, and specimen plants.

Hollies prefer a moist, acid soil well-enriched with organic matter. Plant in sun or shade. Set out as balled-and-burlapped or container-grown plants in spring or fall; make sure that the top of the root ball is the same level at which the plant grew in the nursery. Their roots grow close to the surface, so don't cultivate around them; a deep organic mulch will keep down weeds and provide a cool, moist root zone.

Protect evergreen hollies from winter sun and drying winds with a burlap screen or an antitranspirant spray. Remember to plant both male and female plants, so you'll get the pollination necessary for berries.

Problems

Leaves tunneled. Cause: Leafminers. This tiny insect is by far the most serious pest of hollies. For control information, see "Leaves tunneled" on page 237.

Leaves webbed together. Cause: Bud moths. These 3/8", greenish white caterpillars web together and feed on the tips of new holly shoots in May. Fully grown larvae usually drop to the ground and overwinter in plant debris. Remove fallen leaves around plants. Destroy webs and handpick caterpillars. Spray leaves with BTK in April and May.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. See "Leaves yellow; stems and leaves covered with small bumps" on page 237 for control information.

Leaves stippled with yellow; foliage webbed. Cause: Spider mites. For controls, see "Leaves stippled with yellow; foliage webbed" on page 236.

Leaves with notched margins. Cause: Japanese weevils. The 1/4", brown adults attack foliage, and the legless white grubs feed on roots. Apply a sticky substance to the lower stems to prevent adults from climbing up the plants. Drench the soil around the base of the plant with a solution of parasitic nematodes to control weevil larvae. Spray leaves several times with pyrethrin for major infestations of adult weevils.

Leaves yellowed. Cause: Nitrogen deficiency. This is usually most noticeable on older leaves. Regular fertilization helps keep hollies green and vigorous. Apply cottonseed meal or a generous mulch of compost in early spring.

Leaves and shoots blackened; leaves with moist or brown sunken spots. Cause: Anthracnose. See "Leaves and shoots blackened; leaves with moist or brown sunken spots" on page 238 for more details.

Leaves with spots. Cause: Leaf spots. See "Leaves with spots" on page 237 for controls.

Leaves with powdery white coating. Cause: Powdery mildew. For control information, see "Leaves with powdery white coating" on page 237.

Trunk or branches with oozing lesions; branch tips die back. Cause: Canker. See "Trunk or branches with oozing lesions; branch tips die back" on page 238.

Leaves mottled yellow. Cause: Whiteflies. These tiny, white, mothlike insects and their even smaller larvae feed on the undersides of leaves, weakening the plant. Spray leaves (make sure you get the undersides, too!) with insecticidal soap, or pyrethrin as a last resort; repeat weekly until pests are under control.

Impatiens

Impatiens, balsam.
Perennials grown as annuals.

In American gardens, the 2 most widely grown species of the genus *Impatiens* are garden balsam (*I. balsamina*) and impatiens (*I. wallerana*). Garden balsam grows upright to 2′ with a 1½′ spread. The clustered flowers resemble small double camellias. Impatiens reach 6″-24″ high and about 1′ wide, with open, single flowers. Flower colors include white, red, rose, and orange.

While many gardeners prefer to buy nursery-grown plants, the best color choices usually come in seed packets. Sow seed indoors 8 weeks before last frost. Do not cover the small seeds with soil; they need light to germinate. Germination time is 5 days for balsam, 2 weeks for impatiens. Transplant outdoors 2 weeks after last frost.

Balsam can grow in full sun, while impatiens prefer some shade, especially in warm weather. These otherwise rather care-free plants do not tolerate cold, wet weather. They do require slightly moist soil with lots of organic matter. Water regularly to keep the soil moist but not soggy. Feed balsam once a month to maintain the dark green leaf color. Impatiens don't need extra feeding; too much fertilizer gives ample foliage but few flowers. Pinch back young plants for denser growth. Plants often self-seed.

Problems

Leaves, stems, and buds distorted. Cause: Aphids. For controls, see "Leaves, stems, and buds distorted" on page 20.

Leaves with large, ragged holes. Cause: Slugs and snails. See "Leaves with large, ragged holes" on page 18 for controls.

Seedlings die. Cause: Damping-off. See "Seedlings die" on page 20 for controls.

Ipomoea

Morning glory. Annuals.

These quick-growing tropical vines have white, pink, or blue, trumpet-shaped flowers that may reach 3″ wide. Older types close by midday, but new cultivars stay open longer. Vines may reach 10′ high within 2 months of seeding and flower profusely from July until November. Use morning glories to beautify a fence or wall, or as a temporary groundcover.

Direct-seed outdoors in early April. Soak the hard-coated seed in tepid water for 8 hours, or notch them with a file to speed germination. Place in loose, well-prepared, average soil. Or start seeds indoors in 4″ pots and transplant outdoors after frost.

Full sun is best. Plants require little water or fertilizer once established. Insects and diseases rarely attack plants.

Iris

Iris, flag. Bulbs or rhizomes.

Irises offer a huge range of colors and patterns, heights, and bloom times, with variations on a common flower shape and plant form. The basic iris flower consists of 3 inner (often erect) petals, called standards, surrounded by 3 outer petals (usually arching out), called the falls. Long, flat leaves resem-

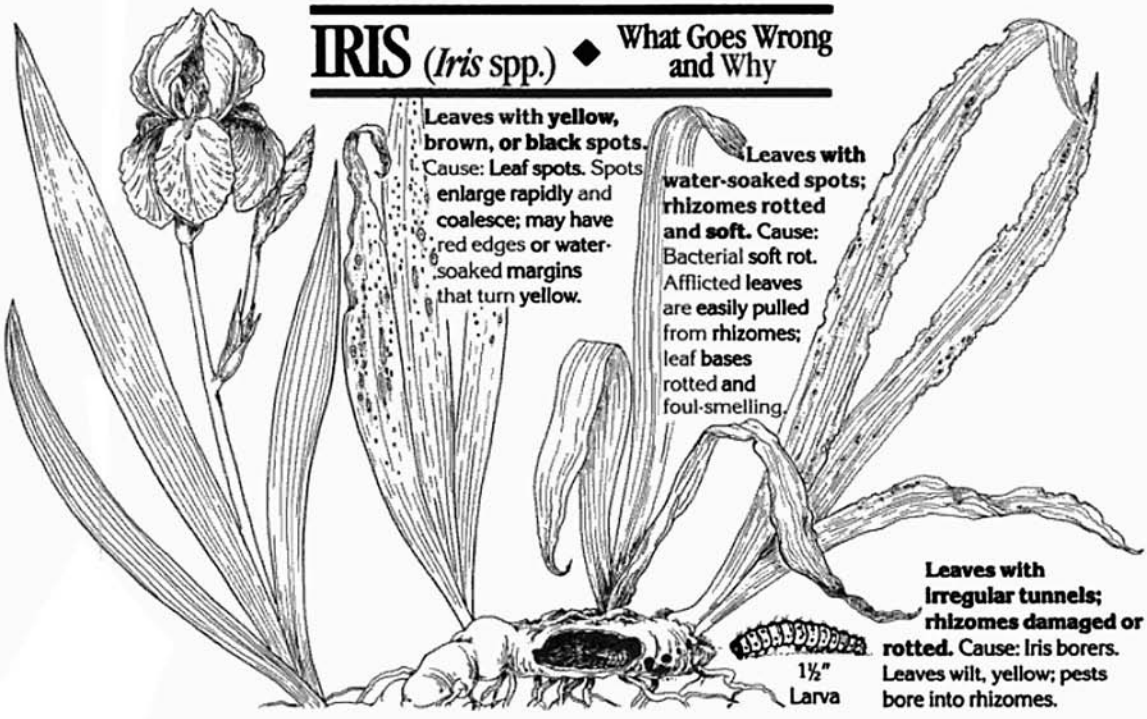
ble swords or grass; they grow in rather open to quite dense upright or arching clumps from bulbs or creeping rhizomes.

By far the most popular group is the large collection of hybrids termed the bearded irises, named for the hairy, caterpillar-like feature creeping out of the center of each fall. Flowers range from 2″ to 7″ wide in one of the widest color ranges of any plant group, lacking only pure red. They bloom in early summer, from 2″ to nearly 5′ above stiff, swordlike leaves.

In place of a beard, "beardless" irises flaunt a colorful spot, called a signal, or an intricate pattern of lines. Blooms on Siberian iris (*Iris sibirica*) rarely exceed 3″ wide; they occur in shades of white, red-violet, blue, and purple (occasionally pinks and yellows) in upright, grassy clumps averaging 3′ tall. They bloom as bearded irises stop flowering. Japanese irises (*I. ensata,* formerly *I. kaempferi*) bear 4″-10″ flattish or double flowers in shades of white, pinkish lavender, red-violet, blue, and violet, often edged, lined, or speckled. Most grow to about 3′ and bloom a few weeks later than Siberian irises.

Very early spring-blooming, bulbous reticulated iris (*I. reticulata*) hybrids have fragrant, narrow-petaled, 3″ blooms, mostly in blues and purples with orange or yellow signals, amid sparse, 4-sided leaves that grow to 1½′ after bloom.

Most bearded irises are easy to grow, but they do have specialized needs. Plant and divide (every 3-4 years) in summer or early fall, splitting them into individual "fans" with the rhizome attached, or into divisions with a few


IRIS (*Iris* spp.) ◆ What Goes Wrong and Why
Leaves with yellow, brown, or black spots. Cause: **Leaf spots.** Spots **enlarge rapidly** and **coalesce; may have** red edges **or water-soaked margins** that turn **yellow.**
Leaves with water-soaked spots; rhizomes rotted and soft. Cause: Bacterial **soft rot.** Afflicted **leaves** are **easily pulled** from **rhizomes;** leaf **bases** rotted **and** foul-smelling.
Leaves with irregular tunnels; rhizomes damaged or rotted. Cause: Iris borers. Leaves wilt, yellow; pests bore into rhizomes.
1½″ Larva

fans. Trim leaves back before planting to make up for root loss. Plant in full sun or very light shade and average to rich, well-drained soil. Barely cover the rhizome and point the leafy end in the direction you want it to grow.

Bearded irises tolerate drought very well when dormant (usually beginning about 6 weeks after bloom), but water them well until dormancy sets in and after division. Fertilize routinely in spring and early fall, keep weeds and other plants away from rhizomes, mulch loosely the first winter after division, and plan to stake tall-growing cultivars when in bloom.

Siberian irises enjoy conditions similar to those favored by bearded irises, but tolerate wetter soil and need less-frequent division in spring or fall. Replant as soon as possible after dividing.

Grow Japanese irises in much the same way, providing shade from the hottest sun. Water well before and during bloom. They need acid soil and benefit from a few inches of mulch in summer.

Plant reticulated irises in fall, about 3″ deep and a few inches apart in average to more fertile, very well drained soil. Grow with annuals and perennials to fill gaps left by their leaves, which wither by summer.

Problems

Leaves with irregular tunnels; rhizomes damaged or rotted. Cause: Iris borers. The most destructive pest of irises, these moth larvae favor bearded irises, but may feed on all species. They seldom bother Siberian irises. Borer eggs hatch in spring, producing up to 2″ long, fat, pinkish larvae. The larvae enter a fan at the top and tunnel down toward the rhizome, where they may eat the whole interior without being noticed. Borers often introduce soft rot bacteria into rhizomes as they feed.

In fall, remove dead, dry leaves, which often carry borer eggs, and destroy badly infested fans in spring. You can also crush borers in the leaves by pinching toward the base of the telltale ragged-edged leaves or by running your thumb between the leaves and squashing any borers you find. Check rhizomes when you divide the clumps for this pest. If you find a few borers, try cutting them out; destroy badly infested rhizomes. In spring, dust the base of plants with pyrethrin to kill emerging larvae.

Leaves with large, ragged holes. Cause: Slugs and snails. These slimy pests live and feed amid dense iris foliage. See "Leaves with large, ragged holes" on page 50 for controls.

Flower buds die; petals distorted; growth stunted. Cause: Thrips. Several species of tiny thrips infest irises; Japanese irises are especially susceptible. Thrips feed on inner folds of leaves, causing stunted growth and russet or sooty areas on leaves. Tops of plants eventually turn brown and die. Flowers may appear discolored, flecked with white, or deformed. These pests are difficult to control, for they burrow into plant tissue. Don't buy sickly looking irises that may be infested. Remove and destroy severely infested plant parts. Use blue sticky traps to monitor and trap pests. Applications of insecticidal soap may provide some control once pests are spotted in traps.

Leaves with yellow, brown, or black spots. Cause: Leaf spots. Irises may develop leaf spot, caused by several different species of fungi, especially in wet weather. Remove infected plant parts; clean up debris in fall to remove disease spores.

Leaves with water-soaked spots; rhizomes rotted and soft. Cause: Bacterial soft rot. Soft rot attacks during wet seasons in poorly drained soil, entering through wounds in the rhizome made by premature leaf removal or cultivation or carried on the bodies of iris borers. Crowded plants in shady locations are more susceptible to this disease. Infected rhizomes are dry on the outside, but wet, smelly, and slimy inside. This rot may start in the leaves

following borer attack. Water-soaked streaks appear on leaves, which then turn yellow and wilt, starting from the tips. Eventually the entire leaf cluster may fall to the ground. Bulbous irises are not infected by this particular rot.

Control borers to reduce soft rot infection; see "Leaves with irregular tunnels; rhizomes damaged or rotted" above. Remove and destroy rotting rhizomes. Wash tools when cultivating or dividing irises to avoid transmitting the infection. Choose rhizomes carefully, inspecting them for signs of infestation; plant in well-drained soil with adequate sunlight.

Leaves mottled or streaked. Cause: Mosaic virus. Bulbous irises that are stunted and streaked with yellow may carry this virus. Flowers may be mottled and smaller than normal. There is no cure for infected plants; remove and destroy irises showing symptoms. Mosaic virus is spread by sucking insects such as aphids and leafhoppers. Control pests to reduce risk of infection. See "Leaves, stems, and buds distorted, sticky; clusters of small insects" on page 51 for controls.

Stems rot at base. Cause: Crown rot. Crowded plants are most susceptible to this fungal disease. Leaves and stems turn brown at the base, foliage turns yellow, and black spores may appear on stems. White or brown mold may be present. Rhizomes may also rot. Dig and divide iris clumps every few years to avoid overcrowding. Plant in well-drained soil. Avoid damaging crowns when cultivating; keep winter mulch away from crowns.

J·K

Juniperus

Juniper, red cedar. Trees and shrubs.

Junipers are a large group of evergreen trees and shrubs. Foliage in young plants is awl-shaped, in mature plants, flat and scalelike. In some cases, both types of foliage can exist simultaneously on the same plant. Plants are either male or female; the females bear small, berrylike cones. Many species and cultivars are valuable in the landscape. Depending upon their form, junipers are valuable for foundation plantings, as groundcovers, or even as specimen trees. Because they respond well to pruning for shape, they also make effective evergreen hedges.

Junipers are widely tolerant of all but

poorly drained soils. They will withstand drought and grow in low-fertility soils—even seaside conditions. Set them out as balled-and-burlapped or container-grown plants in spring or fall. Full sun suits them best; grown in too much shade, they become spindly and unattractive.

Problems

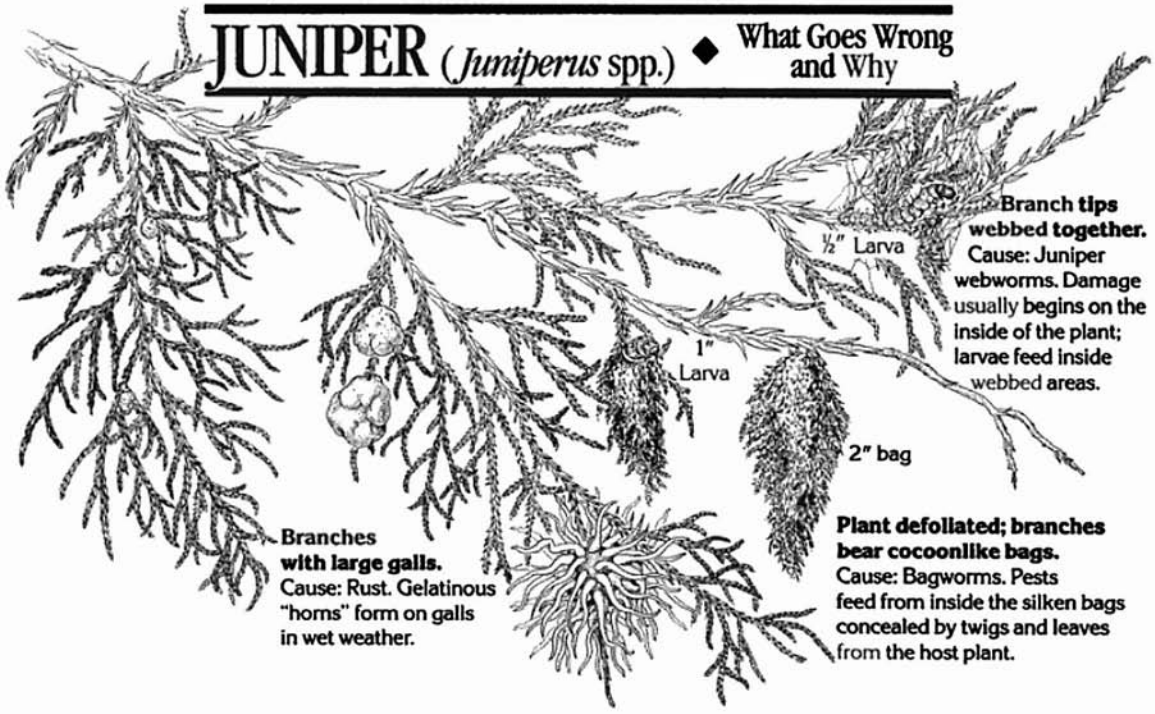
Branches with large galls. Cause: Rust. Cedar-apple rust, cedar-hawthorn rust, and cedar-quince rust are fungal diseases that spend part of their life cycles on junipers, the rest on alternative hosts, such as apples and crab apples. Large galls form and eventually swell to release the spores, especially in warm, moist weather. For an illustration of rust galls on junipers, see below.

Other than producing the galls, rust does little harm to junipers. Cut off and destroy or dispose of galls before early spring. Avoid planting Eastern red cedar (*Juniperus virginiana*) and its cultivars, which are very susceptible to rusts. See "Leaves with pale yellow spots that enlarge and turn orange" on page 25 for information about this disease on apples.

Plant defoliated; branches bear cocoonlike bags. Cause: Bagworms. See below for an illustration of this pest. See "Plant defoliated; branches bear cocoonlike bags" on page 236 for control measures.

Leaves wrinkled and discolored. Cause: Aphids. Several kinds of aphids feed on junipers. For control information, see "Leaves wrinkled and discolored" on page 235.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. For control measures, see "Leaves yellow; stems and leaves


JUNIPER (*Juniperus* spp.) ◆ What Goes Wrong and Why
½" Larva
Branch tips webbed together. Cause: Juniper webworms. Damage usually begins on the inside of the plant; larvae feed inside webbed areas.
1" Larva
2" bag
Branches with large galls. Cause: Rust. Gelatinous "horns" form on galls in wet weather.
Plant defoliated; branches bear cocoonlike bags. Cause: Bagworms. Pests feed from inside the silken bags concealed by twigs and leaves from the host plant.

covered with small bumps" on page 237.

Leaves yellow; whole plant weakened. Cause: Juniper mealybugs. The tiny, powdery white adults generally congregate on the trunks and interior branches, making them difficult to see until the plant starts to weaken. Control by spraying the plant (especially the bark) with superior oil or repeated applications of insecticidal soap.

Leaves stippled with yellow; foliage webbed. Cause: Mites. For control measures, see "Leaves stippled with yellow; foliage webbed" on page 236.

Branch tips webbed together. Cause: Juniper webworms. If left unchecked, this pest can kill the twigs. Remove and destroy the nests, and spray with BTK or pyrethrin as a last resort. See the opposite page for an illustration of this pest.

Needle bases blistered; shoot tips die. Cause: Juniper midges. The tiny yellow larvae of this pest feed on the bases of needles, damaging shoot tips. Prune off infested parts, then spray the whole plant with insecticidal soap. Clean up debris around the base of the tree to reduce the pest population.

Branch tips browned. Causes: Twig blights; cedar bark beetles. Fungal blights may attack junipers in spring or summer. These diseases spread progressively, killing branches or entire plants. Control by pruning and destroying affected branches on a dry day. Avoid by using resistant cultivars, such as *J. chinensis* var. *sargentii* 'Glauca'; ask your local nursery owner or extension agent for others recommended for your area.

Similar symptoms on recently transplanted junipers, or those weakened by drought or by the onslaughts of other insects, may be due to cedar bark beetles. The white larvae of this tiny black beetle tunnel under the bark, sometimes killing weakened trees. The adult beetles chew holes in twig crotches, often causing shoot tips to dangle from the branch. The defense is to keep trees in healthy condition, by watering during dry spells and fertilizing regularly. If damage occurs, prune off damaged tips. Spray with pyrethrin, making 2 applications 3–4 days apart.

Kale

Brassica oleracea
Acephala group (Cruciferae)

Kale is a cool-season vegetable grown for its crinkly, blue-green leaves. It is a very hardy member of the cabbage family, tolerating temperatures below 40°F. In fact, frost improves its taste. It is less tolerant of heat than other members of the cabbage family. In warmer climates grow kale in soil with a high clay content if you have a choice, and shade soil around roots.

Grow kale as you would cabbage. It is occasionally bothered by the same diseases and insects as cabbage. See the Cabbage entry beginning on page 52 for culture and information on problems.

Kalmia

Mountain laurel. Shrubs.

Mountain laurels are broad-leaved evergreen shrubs with clusters of white, pink, or red flowers in spring. They are splendid for woodland plantings, shrub borders, or foundation plantings.

In the spring, set out balled-and-burlapped or container-grown plants. Select a partially shaded location (the further south, the more shade) with moist but well-drained acid soil rich in organic matter. Don't cultivate around these shallow-rooted plants; instead, use a deep organic mulch, which will keep weeds down and provide the cool, moist root zone the plants need.

For information on pests and diseases, see the Rhododendron entry beginning on page 200.

Kiwi

Actinidia arguta, A. deliciosa, and *A. kolomikta* (Actinidiaceae)

Kiwis are vigorous, twining vines. Fruit is borne toward the base of new shoots that grow off last year's canes. The kiwi found in produce markets, *Actinidia deliciosa,* grows in Zones 7-9. *A. arguta* is hardy in Zones 4-7; *A. kolomikta* is hardy in Zones 3-7.

Grow kiwis in full sun or partial shade in perfectly drained soil. Allow about 200 square feet of trellis or arbor for each plant. Male and female flowers appear on separate plants; therefore, a plant of each sex is required for fruit set. A few cultivars are self-pollinating. Check before you buy.

Problems

Leaves skeletonized. Cause: Japanese beetles. These ½", metallic blue-green insects with bronze wing covers like to feed in the sun. Check plants early in the morning while beetles are sluggish and knock them into jars filled with soapy water. Scent-baited traps may be effective if placed at some distance from plants. Some gardeners find that traps attract extra beetles into the garden, so be sure to place them well away from the plants you wish to protect. Populations of this pest naturally decline by midsummer, but for very heavy infestations, spray with neem. For more information, see "Leaves skeletonized" on page 46.

Vines chewed, bedraggled. Cause: Cats. Strange as it may seem, cats like kiwis as much as they like catnip. Protect plants with chicken wire, if necessary.

Plant stunted; leaves yellow. Cause: Crown rot. Kiwis require perfectly drained soil to avoid crown rot. Avoid planting in poorly drained sites and modify soil enough to assure good drainage.

Kohlrabi

Brassica oleracea Gongylodes group (Cruciferae)

Kohlrabi is a cool-season vegetable grown for its crisp, bulbous stems. It looks like an aboveground turnip. Kohlrabi can tolerate temperatures below 40°F and a pH between 5.5 and 6.8.

The trick to growing tender kohlrabi is encouraging rapid growth. Keep young plants well-watered. Harvest bulbs when they are 2"-3" in diameter; they may become fibrous and bitter if allowed to grow larger.

Kohlrabi and cabbage require similar culture and are attacked by the same diseases and insects. See the Cabbage entry beginning on page 52 for culture and information on problems.

L

Lagerstroemia

Lagerstroemia, crape myrtle. Shrubs and trees.

Lagerstroemias, also known as crape myrtles, are popular summer-flowering shrubs and small trees throughout the warmer portions of the United States.

Lagerstroemias require full sun and a moist but well-drained soil enriched with organic matter. They will withstand severe pruning in early spring and still bloom because they produce flowers on the current season's wood.

Powdery mildew can be a serious problem; choose resistant cultivars. For more information, see "Leaves with powdery white coating" on page 237. Aphids may feed on leaves; see "Leaves wrinkled and discolored" on page 235 for controls.

Lantana

Lantana, shrub verbena.
Tender perennials grown as annuals.

Lantana brings masses of color to containers, rock gardens, and hanging baskets. The quick-growing plants can grow to 4′ high by 8′ wide. They are covered with 1″-2″ clusters of small flowers in shades of pink, yellow, orange, red, and bicolors. The plants are frost-sensitive, although they may bloom throughout the year in mild areas. Birds, bees, and butterflies find the plants quite attractive.

Take softwood cuttings from existing plants, or start seeds indoors in midwinter (they germinate in about 8 weeks). In warm climates direct-sowing is effective. Lantanas need full sun and average, well-drained soil. Plant 1½′ apart. Water deeply but let soil dry out between waterings. Fertilize lightly; overfertilization or excess water decreases bloom.

Problems

Leaves yellow; plant weakened. Cause: Whiteflies. For controls, see "Leaves yellow; plant weakened" on page 18.

Leaves and stems with white, cottony clusters. Cause: Mealybugs. See "Leaves and stems with white, cottony clusters" on page 20 for control measures.

Leaves mottled, with shiny black flecks underneath. Cause: Lace bugs. Adult lace bugs are 1/10″, flattened, dark insects with lacy-patterned wings. Both adults and the tiny nymphs feed on the undersides of leaves and produce tiny dots of brown excrement. At the first sign of damage, spray with insecticidal soap, paying particular attention to the undersides of the leaves. Use pyrethrin as a last resort.

Larix

Larch. Trees.

Larches comprise a unique genus—a group of deciduous, needle-leaved conifers. They are trees for cold climates.

Set out in spring or fall as balled-and-burlapped plants. Plant in full sun in moist, acid soil. Larches do not tolerate shade, dry soils, or urban conditions.

Problems

Leaves mined, yellowed, and shriveled. Cause: Larch casebearers. The tiny reddish brown larvae of this moth feed and overwinter inside the leaves. Adult moths emerge in May or June. Natural parasites usually keep this pest under control. For severe infestations, apply a dormant spray of lime-sulfur to branches.

Branches defoliated. Cause: Larch sawflies. In June, the small, wasplike adults lay eggs in the side of larch shoots, causing shoots to twist. These ½"-1", grayish green, caterpillar-like larvae emerge about a week later. They feed on the leaves, starting with lower branches. Remove debris, which provides an overwintering site for the pest, from around trees. Spray shoots with superior oil to control heavy populations.

Trunk or branches with oozing lesions. Cause: Larch branch canker. This fungus produces sunken areas on the bark that are surrounded with drops of resin. Cut out and destroy affected parts as soon as detected; once established, there is no control. European larch (*Larix decidua*) is prone to serious infections; Japanese larch (*L. kaempferi*) is less susceptible to the disease.

Lathyrus

Sweet pea. Annuals.

These fragrant, climbing annuals make excellent cut flowers. Clusters of lavender, pink, or white blossoms appear in spring. Plants can grow 1'-6' tall. Hot weather kills cultivars that aren't heat-resistant.

Soak seeds for 24 hours in warm water to speed germination. Direct-sow in early spring as soon as soil can be worked. Indoors, start in individual peat pots about 7 weeks before last frost. Seeds germinate in 2 weeks.

Plant sweet peas in full sun in a deeply worked bed amended with lots of organic matter. Water deeply and frequently. Remove spent flowers to prolong blooming.

Powdery mildew can occur if air circulation is poor; see "Leaves with powdery white patches" on page 19. If aphids are a problem, see "Leaves, stems, and buds distorted" on page 20.

Lawns

Good organic lawn maintenance is the secret to having an attractive lawn without using synthetic chemicals. If you select the right mix of grass species for your area and maintain soil fertility and organic matter content, you'll have few problems with insects and diseases.

If your lawn is out of condition, or if you've been relying on synthetic fertilizers

and pesticides to keep it growing, here are some steps you may need to take to develop a lush, organic lawn.

■ Mow regularly to the recommended height for the grasses in your lawn, and leave the clippings on the lawn. Grass clippings are one of the best organic fertilizers for lawns.

■ Check soil pH, and adjust if necessary. Most grasses do best at pH 6.0-7.0.

■ Top-dress your lawn with a ¼"-½" layer of finished compost, dehydrated cow manure, or other fine organic matter.

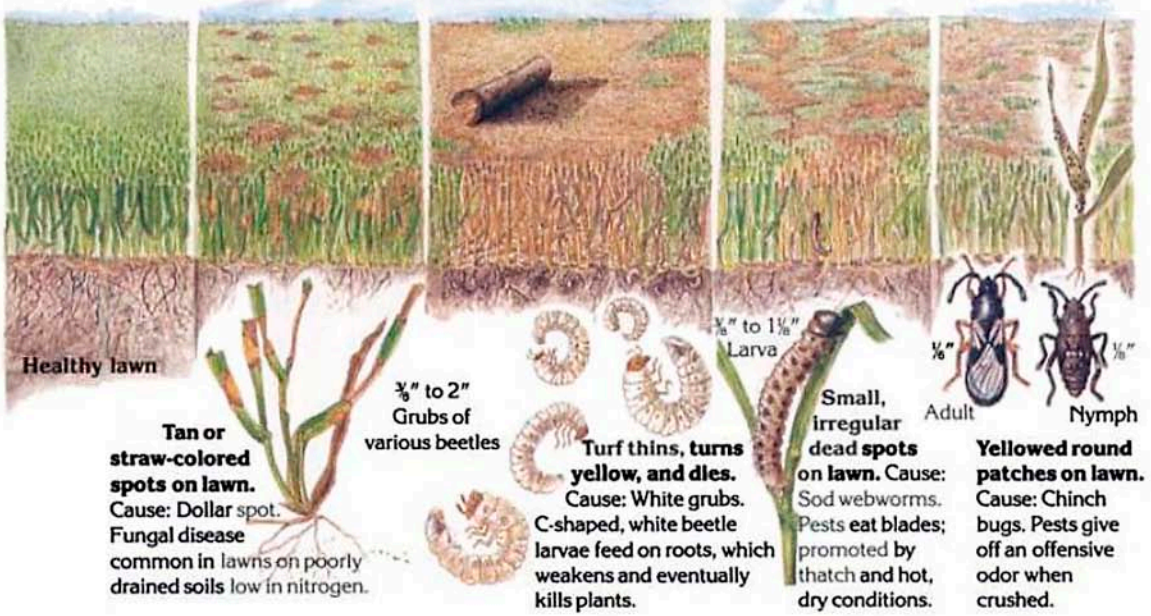
■ Fertilize once a year—in spring and early fall for northern lawns, in spring or summer for southern lawns.

■ Water deeply and infrequently to encourage grasses to develop deep roots so they'll be more drought-tolerant.

■ If your lawn gets lots of foot or vehicle traffic or is growing in heavy soil, aerate the soil to loosen it and encourage deeper root growth. You can rent a motorized or power-driven aerator, or aerate manually with a spading fork. At 1' intervals all over your lawn, insert a spading fork into the turf at a 45-degree angle. Push the tines in to a depth of 4". Press down slightly on the fork handle to loosen the soil, and then pull out the fork.

■ If your lawn has a buildup of thatch—undecomposed plant debris at the soil surface—thin it out by raking the lawn with a special

LAWNS ◆ What Goes Wrong and Why


Healthy lawn
Tan or straw-colored spots on lawn. Cause: Dollar spot. Fungal disease common in lawns on poorly drained soils low in nitrogen.
⅜" to 2" Grubs of various beetles
Turf thins, turns yellow, and dies. Cause: White grubs. C-shaped, white beetle larvae feed on roots, which weakens and eventually kills plants.
⅛" to 1⅛" Larva
Small, irregular dead spots on lawn. Cause: Sod webworms. Pests eat blades; promoted by thatch and hot, dry conditions.
⅛"
⅛"
Adult
Nymph
Yellowed round patches on lawn. Cause: Chinch bugs. Pests give off an offensive odor when crushed.

thatching rake, available from nursery suppliers and mail-order tool companies. For very large lawns, you will need to rent a machine called a dethatcher.

■ If your lawn is in bad condition, or suffering from severe insect or disease problems, you may decide to start from scratch. If so, be sure to choose the best grass or mixture of grasses for your area. Cool-season grasses, which grow the most in spring and fall and are dormant in midsummer, are best for the northern half of the country. Warm-season grasses, which are dormant in winter and begin growing in early summer, are best for the desert southwest and the Sun Belt. There are many disease- and insect-resistant cultivars available. One group, the endophyte-containing grasses, hosts fungi that produce a substance that deters feeding by some insect pests and is actually toxic to other pests. Check with your local extension office or garden center for the best new cultivars for your areas.

Problems

Turf has bare or ragged patches. Cause: Armyworms. These greenish brown caterpillars with white stripes and black heads chew grass blades down to the crowns, leaving bare areas or ragged patches of grass. They are a common pest on bermudagrass during cool, wet periods. In the South as many as 6 generations may occur in 1 year. Spray affected areas with parasitic nematodes while larvae are still feeding. Spray feeding larvae with BTK. Remove dead areas of turf. Reseed and overseed with resistant grasses such as the endophyte-containing cultivars.

Grass blades yellowed; thinned, brown turf. Cause: Mites. These tiny, 8-legged creatures suck sap from grass blades, causing them to turn yellow or straw-colored. Heavy infestations can kill plants, leaving turf looking brown and sparse. They thrive on poorly fed lawns and during dry conditions. Improve fertility and keep lawns well-watered during dry spells. For serious infestations, spray with insecticidal soap.

Turf with yellow or brown patches. Cause: Billbugs. Billbug larvae are white grubs with yellow-brown heads that feed on grass stems, causing shoots to turn brown and die. In warm weather the grubs tunnel into the soil and feed on roots and rhizomes. Billbugs are brown or nearly black, 1/4"-1/2" weevils. Control grubs by aerating the lawn, watering deeply, removing thatch, and adding organic matter. Reseed or overseed with resistant cultivars.

Yellowed round patches on lawn. Cause: Chinch bugs. These bugs suck plant sap, causing grass to turn yellow and die off in patches. Adult chinch bugs have 1/6", dark bodies with a black triangular pad between white, folded wings. Nymphs are tiny bright red insects with a white band across their backs. Both adults and nymphs cause damage, especially during dry conditions. See page 133 for an illustration of the pest and its damage.

The pests congregate in open, sunny parts of the lawn. They smell bad, especially when crushed. You may be able to detect the odor simply by walking across a severely infested lawn. To check for chinch bugs: Remove both ends from a large coffee can. Push one end 2" into the sod, using a knife to cut the ground so the can inserts easily or a board to hammer it in place. Fill the can with water. Chinch bugs will float to the surface within 10 minutes. If there are 20 or more bugs in the can, monitor the population weekly, and take steps to control, if necessary.

Encourage native predators, including bigeyed bugs, minute pirate bugs, lacewings, lady beetles, and birds. Drive out chinch bugs by keeping the soil very moist. Wet it to a depth of 6", and maintain that moist condition for 3-4 weeks. To control chinch bugs in small lawns, soak sod with soapy water (1 ounce liquid dish soap to 2 gallons water),

then lay a flannel sheet over the grass to snare the bugs as they are driven out by the soapy solution. Pick up the sheet and rinse it out in a bucket of soapy water to kill the chinch bugs. Rinse the soap off the treated grass by watering well. Seed and reseed treated areas with resistant cultivars.

Grass chewed. Cause: Grasshoppers. These common insects chew on grass, but usually aren't a serious threat to lawns. Broadcast *Nosema locustae* spores mixed in a bran bait (available commercially) as soon as grasshoppers emerge in spring: Effects of this measure usually aren't realized until the second summer after application.

Turf has irregular streaks of brown grass. Cause: Mole crickets. These 1½", light brown insects have short forelegs and shovel-like feet. They are serious lawn pests in the South. The crickets tunnel under the lawn and feed on grass roots. Infested grass wilts and turns brown, so irregular dark streaks appear on lawns. Apply parasitic nematodes and water the soil well before and after application, or apply milky disease spores.

Small, irregular dead spots on lawn. Cause: Sod webworms. Webworms sever grass blades just above the thatch line and pull the blades into a silken tunnel in the ground to eat. As they feed and tunnel, irregular dead patches appear in the lawn. They are most often a problem on bluegrass, hybrid bermudagrasses, and bentgrasses in the South. Webworms are the larvae of the buff-colored lawn moth, which fly over lawns in late spring. Hot, dry conditions and thatch buildup encourage the pests.

Control webworms by saturating infested areas with a soap drench (2 tablespoons liquid dish soap to 1 gallon water) to drive the larvae to the surface. Rake the pests into a pile and dump them into a bucket of soapy water. Apply BTK or drench the soil with parasitic nematodes when pests are in their larval stage (usually about 2 weeks after moths appear). Spray severely infested areas with pyrethrin if all other attempts at control fail.

Turf thins, turns yellow, and dies. Cause: White grubs. These curved, fat, whitish larvae of Japanese beetles and other beetle species chew on grass roots, leaving sections of lawn that appear burned. Damaged turf can be easily lifted from the lawn. Ten or more grubs per square foot is a serious infestation. Japanese beetle grubs are most common on cool-season grasses. Grubs of other species such as scarab beetles, European chafers, and oriental beetles feed on bentgrasses, Kentucky and annual bluegrasses, and fescues.

Walk the turf in spiked sandals (available through mail-order catalogs) that will pierce and kill the grubs. For a large lawn, apply milky disease spores: This treatment will eliminate Japanese beetle grubs over a few seasons. Apply the material in late spring or fall when soil temperature is at least 70°F, but while grubs are still present. Or apply predatory nematodes to control both Japanese beetle grubs and other white grubs. Water the soil well before and after application to improve results.

Turf has brown circular patches. Cause: Brown patch. This fungus causes circular areas of grass up to 2' in diameter to turn brown and die. It tends to attack St. Augustine grass, bentgrass, bermudagrass, zoysia grass, tall fescues, and ryegrasses, especially during hot, humid weather. Close cutting, poor drainage, overwatering, excessive nitrogen, and low pH all contribute to brown patch. Control the disease by reducing nitrogen fertilization, mowing less frequently, aerating, and dethatching. Top-dress with humus-building material. Water less frequently and only during the day so grass dries off quickly. Rake out dead grass and replant bare spots with resistant grasses.

Tan or straw-colored spots on lawn. Cause: Dollar spot. This fungus causes tan or straw-colored spots the size of silver dollars to appear

on the lawn. The fungus occurs widely on golf greens, but may also be a severe problem on low-nitrogen, poorly drained lawns. Aerate the soil and improve drainage by top-dressing with organic matter. In the meantime, keep soil well-watered. Apply a high-nitrogen fertilizer; applying seaweed extract is also helpful. Mow less frequently, if possible. Overseed in fall with resistant cultivars.

Green spots outlined with brown on lawn. Cause: Fairy ring. If your lawn has bright green circular areas that seem to grow more rapidly than the rest of the lawn, the grass is probably infected by fairy ring fungus. A ring of grass around the green spots turns brown; the green areas eventually will brown out also. A circle of mushrooms usually develops around the edge of the infected area. Rake and discard the mushrooms as they appear. Spike the area with a spading fork every day. Water well. Encourage beneficial soil microbes by top-dressing with finished compost or an organic lawn fertilizer. Eradicate the fungus by digging out the soil in the area of the ring. Dig down 2′ and extend the hole outward at least 1′ out from the ring. Remove the soil carefully, being sure not to spill any infected soil on the healthy lawn. Fill in the hole with humusy topsoil and finished compost and reseed.

Reddish brown, tan, or yellow patches develop on lawn. Cause: Fusarium blight. This disease is common on Kentucky bluegrass during periods of hot, humid weather. Infected lawns develop spots of reddish brown grass 2″-6″ in diameter. The spots later turn tan and finally yellow. Roots will rot and may be covered with pink mold. Dethatch and aerate the lawn. Apply 1″-2″ of water each week. Raise the mowing height in summer. Don't fertilize in late spring or early summer. Rake out dead grass and replant with Fusarium-resistant cultivars.

Grass blades have dark spots. Causes: Leaf spots; leaf blights. Several fungi cause grass to develop reddish brown to black spots on the leaf blades. Grass shrivels and roots rot. Hot, humid conditions favor fungal growth. Fight leaf spots and blights by building soil fertility. Set mowing height as high as recommended for your grass mix. Don't mow during disease outbreaks to avoid spreading the fungi. Keep soil evenly moist. Restore diseased areas by raking out diseased grass and top-dressing with finished compost. Reseed or overseed with resistant cultivars.

Grass water-soaked, blackened. Cause: Cottony blight. Infection by *Pythium* fungi causes patches of grass to turn black and look water-soaked. In humid conditions a cottony mold may appear. The disease usually occurs in wet, poorly drained areas that have been overfertilized. It spreads rapidly once established. Alkaline soils and calcium deficiency encourage the disease. Aerate and dethatch lawn. Have the soil tested and correct calcium deficiency, if necessary. Reduce nitrogen fertilization, particularly in fall. Keep soil evenly moist. Maintain slightly acid soil. In severely infected areas enrich soil with organic matter to improve drainage, and replant.

Circular, scorched patches or pink, gelatinous masses on lawn. Causes: Red thread; pink patch. Lawns infected by red thread fungus have circular patches of dried grass that have red or rusty threads on the blades. Lawns suffering from pink patch will develop pink, gelatinous masses on leaf blades. These related fungal diseases are common on bentgrass, bluegrass, fescue, and ryegrass, especially in cool, humid regions. Apply an organic fertilizer with nitrogen in readily available form, such as seaweed extract. Mow regularly to remove infected leaf tips. Water regularly and thoroughly.

Grass blades develop yellow to red, powdery blisters. Cause: Rust. Infection by this fungus causes yellow to rusty red, powdery spore blisters to appear on leaf blades. Seri-

ously infected lawns turn yellow and wither. Rust typically occurs in late summer on dry lawns lacking nitrogen. To avoid problems, water the lawn well in the early morning, so the grass can dry off quickly. Fertilize using seaweed extract or other nitrogen-rich fertilizer. Mow regularly. Rake out dead grass and overseed with resistant cultivars.

Lettuce

Lactuca sativa (Compositae)

Lettuce is a hardy annual grown for its tender leaves. The 3 most common types of lettuce are: leaf or bunching, head (including butterhead and crisphead), and cos or romaine.

Culture

Lettuce grows best in rich, loose soil with a pH between 6.0 and 6.8. It likes full sun, but in hot weather does better with light shade in the heat of the day. Lettuce needs to grow rapidly and without interruption. Provide plenty of nitrogen in both quicker-release forms, such as blood meal or soybean meal, and slower-release forms, such as compost or alfalfa meal. Spray the plants with compost tea and/or seaweed extract every other week to give them an extra boost. Spraying with compost tea may also help prevent some fungal disease problems.

Lettuce grows best at temperatures between 60° and 65°F. Most lettuce cultivars grow poorly above 75°F, but will tolerate temperatures as low as 45°F. Plants exposed to high temperatures will bolt. Prevent bolting by providing plants with partial shade in the heat of the summer, harvesting promptly, and planting bolt-resistant cultivars.

To grow tender, trouble-free lettuce, keep the soil moist, but not soggy, and do not allow it to dry out. Unlike most vegetables, lettuce responds well to having its foliage sprinkled with water. Plant in raised beds to improve drainage. To help prevent disease problems, do not plant lettuce in soil where it has been grown within the last 3 years.

Lettuce seeds will not germinate if soil temperatures are above 80°F. In the heat of the summer, start seedlings in a cool, shaded location and then transplant them into the garden.

Various nutrient deficiencies can affect lettuce. Boron or phosphorus deficiency causes malformed plants. Calcium deficiency causes browning of young leaves. Poor heart formation is a symptom of molybdenum deficiency. Copper deficiency prevents heads from forming. Spray seedlings with seaweed extract to help prevent nutrient deficiencies. Continue to spray plants with seaweed extract or compost tea every 2 weeks to boost plant health. Do a soil test to confirm the deficiency, and amend soil accordingly.

Problems

Seedlings rot near soil line and fall over; seeds do not germinate. Cause: Damping-off. Keep soil moist, but not soggy. Thin seedlings and spray with compost tea as soon as first true leaves open to help prevent problems.

Seedlings clipped off at soil line. Cause: Cutworms. Once a seedling is clipped off, there is nothing to do but protect the remaining seedlings from nocturnal cutworm attacks. Check for fat, 1"-2" long, brown or gray caterpillars in the soil near the base of plants. Place cutworm collars around transplants, sprinkle moist bran mixed with BTK on the soil surface in the evening, or add parasitic nematodes to the soil at least 1 week before planting to control them.

Leaves yellow. Causes: Excessive heat; nitrogen deficiency; waterlogged soil. Plants

are stunted and leaves are tough and bitter. Temperatures above 80°F will produce these symptoms. Prevent problems by planting heat-tolerant cultivars and providing partial shade for plants in the heat of the summer.

If weather is not extremely hot, the problem is probably nitrogen deficiency. Spray plants and drench roots with fish emulsion or fish-meal tea to alleviate symptoms. Waterlogged soil produces the same symptoms by damaging roots. Keep soil moist, but not soggy. Plant in raised beds if drainage is a problem.

Plant yellow and stunted; plant wilts during bright, hot days and recovers at night. Causes: Wireworms; nematodes. Wireworms are yellow to reddish brown, slender, tough-bodied, segmented worms up to 1½" long, with brown heads. Adults are dark-colored, elongated click beetles. Apply parasitic nematodes to the soil to control them, and avoid planting where sod was the previous year.

Root knot nematodes cause enlargements or galls on roots. Control pest nematodes by applying chitin or parasitic nematodes to the soil.

Young leaves yellow and distorted. Causes: Tarnished plant bugs; aphids; big vein. Tarnished plant bugs are oval, light green to brown, ¼" long insects with triangles on their backs. Nymphs are smaller and yellow-green. When they feed, they inject a toxin into plants that causes distorted growth. Trap them with white sticky traps. Treat plants with a commercial pyrethrin spray or dust in the evening if infestation is heavy. Till soil after harvest to reduce overwintering pests.

Aphids are soft-bodied, small, green, black, gray, pink, or white fluffy-coated, sucking insects that can spread diseases. For light infestations, knock pests off plants with a blast of water. Spray plants with insecticidal soap to control or with neem or pyrethrin if infestation is heavy. Cover plants with row cover when they come up to prevent problems.

Big vein is a disease that causes light green or yellow, crinkled leaves with lighter, enlarged veins. Infected plants are stunted. The disease is carried by a fungus and may be caused by a viruslike organism. Destroy infected plants. Prevent problems by not planting in cold, wet soils or where big vein has been a problem in the past.

Leaves pale; plant stunted. Cause: Leafhoppers. Leaves may appear stippled. These green or brown, wedge-shaped, 1/10"-½" long insects feed on plant sap and can spread diseases. Treat infested plants with insecticidal soap in the evening or with a commercial pyrethrin spray or dust if infestation is severe. Prevent problems by covering plants with row cover when they germinate.

Leaves dull gray-green or silvery. Cause: Thrips. Leaves may turn brown and papery. These tiny, spiderlike insects can barely be seen with the naked eye. To check for thrips, tap a leaf over a white paper and look for moving specks. Trap thrips with sticky traps or spray plants with insecticidal soap to control them. Try blue, yellow, and white sticky traps placed just above plant height to see which color works best.

Young leaves are dwarfed, curled, or twisted. Cause: Aster yellows. There is no cure for infected plants; destroy them. Control leafhoppers because they spread this disease. See "Leaves pale; plant stunted" above for leafhopper controls.

Leaves mottled and ruffled. Cause: Mosaic virus. Plants are stunted. Destroy infected plants as soon as possible. Control aphids that spread the disease. See "Young leaves yellow and distorted" above for controls. Prevent problems by planting resistant or tolerant cultivars such as 'Don Juan', 'Greenfield', 'Montello', 'Nancy', 'Paris Island Cos', 'Salad Bibb', and 'Salad Crisp'.

Leaves covered with white powdery coating. Cause: Powdery mildew. Older leaves are usu-

ally affected by this fungal disease. Infected leaves curl, turn yellow, and eventually turn brown and die. Spray plants with a baking soda solution (1 teaspoon per quart of water) or sulfur as soon as disease appears to prevent further infection, and thin plants to increase air movement.

Leaves with yellow or light green spots. Cause: Downy mildew. Undersides of spots develop a fluffy white growth. Affected areas eventually turn brown. In severe cases plants become brown and stunted. Downy mildew is a fungal disease common in warm, damp, foggy weather. Spray plants with sulfur in the evening to prevent further infection. To prevent problems, plant cultivars, such as 'Alpha DMR', 'Cal K-60', 'Don Juan', 'El Toro', 'Erthel', 'Morangold', 'Salad Bibb', 'Salinas', and 'Tania', that are tolerant of downy mildew.

Leaves with dark or water-soaked spots. Cause: Various bacterial or fungal leaf spot diseases. Destroy badly spotted plants or leaves. Thin plants to increase air movement, and avoid wetting leaves when watering. Prevent problems by keeping plants well-fed.

Leaf margins brown and dried. Causes: Tipburn; freezing injury. Tipburn also causes dark spots on veins. This condition is prevalent in hot weather and is related to uneven soil moisture and a shortage of calcium in the leaves. To prevent problems, keep the soil moist, but not soggy, and do not allow it to dry out. Plant cultivars that are somewhat resistant to tipburn, such as 'Cal K-60', 'Canasta', 'Don Juan', 'Empire', 'Grand Rapids TBR', 'Green Lake', 'Mesa', 'Montello', 'Paris Island Cos', 'Salinas', 'Slobolt', and 'Waldmann's Green'.

Temperatures below 35°F cause outer leaf margins to turn tan and leaves to blister. Protect plants with row cover if low temperatures are predicted.

Leaves with discolored midribs. Cause: Excessive heat. Midribs remain firm. Temperatures above 80°F can cause midrib discoloration. Cover plants with shade cloth when temperatures soar, or plant in partial shade. Certain cultivars, such as 'Ithaca', are less susceptible to this condition.

Whole plant collapses or rots. Causes: Bottom rot; lettuce drop; gray mold. Bottom rot first infects the lower leaves that touch the ground. Dark, sunken spots develop on midribs, then entire leaves turn brown and slimy. Entire plant may be affected in severe cases. The same fungus causes diseases on many different vegetables, so preventive rotation is difficult. Prevent bottom rot by planting resistant cultivars such as 'Canasta'. Lettuce drop fungus causes plants to wilt and collapse, outer leaves are affected first. Gray mold fungus also starts at the bottom of the plant and turns it into a slimy, brown mess. The center stem and heart may rot out before the outer leaves are affected. 'Montello' is tolerant of gray mold.

Destroy infected plants or leaves and thin remaining plants to increase air movement. Prevent problems by working lots of compost into the soil before planting, and plant lettuce in raised beds to improve soil drainage. Spray plants with compost tea every 2 weeks to help suppress diseases.

Leaves with wandering, white or translucent tunnels. Cause: Leafminers. Larvae are white and maggotlike and burrow through leaves, leaving empty tunnels. Adults are tiny black-and-yellow insects. Destroy infested leaves. Catch adults with sticky traps; try blue, yellow, and white to see which color works best. Control heavy infestations of adults by spraying plants with pyrethrin. Once the larvae are inside leaves, spraying is generally useless. Certain parasitic nematodes will attack leafminer larvae in the leaf tunnels. Prevent problems by covering plants with row cover when they germinate.

Leaves with small holes. Cause: Flea beetles. These small, shiny, black beetles hop

when disturbed. Treat plants with a commercial pyrethrin spray or dust to control severe infestations. Protect plants with row cover as soon as they germinate.

Leaves with large holes. Causes: Caterpillars; slugs and snails. If there are green droppings on leaves and below plants, look for caterpillars feeding on leaves. Spray plants with BTK to control them.

If there are shiny slime trails on the remaining leaves, slugs and snails are at work. Sprinkle wood ashes or diatomaceous earth around plants, or trap the pests in shallow pans filled with stale beer and empty traps daily.

Leaves cut back or missing. Cause: Animal pests. Lettuce is a favorite snack for rabbits and groundhogs. See "Stopping Animal Pests" on page 408 for control methods.

Liatris

Gayfeather, blazing-star. Perennials.

These striking upright plants provide bottle-brush-type flower spikes of pink to purple with stemless, grasslike leaves that become smaller as they progress up the spikes. Gayfeathers range in height from 3′ to 6′; flowers open from the tops of spikes downward and bloom in summer and into fall.

Plant in full sun. These tough natives of the Great Plains tolerate poor to average soils, heat, cold, and some drought, but are at their best in moist, well-drained soil. Gayfeathers may self-sow under optimum conditions but are rarely invasive. Cut spent spikes back by a third, leaving the rest to produce food for continued growth. Tall species and cultivars may need staking. Divide every 4 years if plants seem crowded.

Problems

Plant fails to thrive. Cause: Root knot nematodes. Gayfeathers have no significant pests or diseases, but in some states the southern root knot nematode is a problem. Microscopic in size, soil-dwelling nematodes are roundworms that feed on roots. Their feeding impairs uptake of nutrients and water. Plants fail to thrive, but otherwise show few aboveground symptoms beyond midday wilting in summer drought. Root knot nematode feeding causes numerous knobby root swellings that don't rub off. Control is difficult; avoid planting gayfeathers in areas of known nematode activity. Encourage natural enemies of nematodes by adding organic matter to soil; solarize infested soil as described on page 424; rotate nonsusceptible crops into infested sites. Soil drenches of neem and applications of chitin also help control root knot nematodes.

Ligustrum

Privet. Shrubs.

Privets are opposite-leaved, deciduous or evergreen shrubs. They are easy to grow and readily lend themselves to pruning, which helps explain their popularity for hedges.

Privets will grow in full sun or partial shade and tolerate almost all soils except poorly drained ones. Set out in spring or fall. They benefit from a deep organic mulch.

Problems

Leaves wrinkled and discolored. Cause: Aphids. For control measures, see "Leaves wrinkled and discolored" on page 235.

Leaves tunneled. Cause: Leafminers. See

Copyrighted material

"Leaves tunneled" on page 237 for controls.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. For controls, see "Leaves yellow; stems and leaves covered with small bumps" on page 237.

Leaves with notched margins. Cause: Japanese weevils. The ¼", brown adults attack foliage, and the legless white grubs feed on roots. Apply a sticky coating, such as Tanglefoot, to lower stems to prevent adults from climbing up the plants. Drench the soil around the plant base with a solution of parasitic nematodes. Spray leaves several times with pyrethrin for major infestations.

Leaves stippled with yellow; foliage webbed. Cause: Spider mites. See "Leaves stippled with yellow; foliage webbed" on page 236 for suggested controls.

Leaves and shoots blackened; leaves with moist or brown sunken spots. Cause: Anthracnose. See "Leaves and shoots blackened; leaves with moist or brown sunken spots" on page 238 for controls.

Leaves with powdery white coating. Cause: Powdery mildew. See "Leaves with powdery white coating" on page 237 for controls.

Lilium

Lily. Bulbs.

Hybridizers have created a glorious mix of lilies with 3"-12" flowers in a variety of distinctive shapes, resembling peaked caps, turbans, bowls, trumpets, or broad, curly stars. They bloom in shades and combinations of white, pink, red, yellow, orange, lilac, and green, many dotted in maroon or near-black. Plants bear a few to 2 dozen or more flowers atop 2'-7', upright stems clothed in narrow leaves. Most lilies are hardy in Zones 3-8, with protection in the North, especially during the first winter.

Lilies thrive in sun or part shade in deep, fertile, moist but well-drained, humus-rich soil out of strong winds. Unlike the hard, dense bulbs of tulips and daffodils, a lily bulb is a fragile package of individual scales joined together rather loosely, making it quite prone to damage and drying out. Also, lilies never go completely dormant; plant them carefully, as soon as possible after you receive them. It is preferable to plant them in fall, although spring planting is quite common. Many specialists prepare the soil to 1½' deep on a warm fall day and mulch the site heavily to keep the soil unfrozen and ready for planting in very late fall, which is when many dealers ship lilies. Most lilies produce roots along the length of their below-ground stems, which help to feed and support the large plants. Therefore, even tiny lily bulbs should have no less than 6" of soil above the top of the bulb.

Mark the planting sites to help avoid injuring the newly emerging shoots. As they appear in spring (sometimes surprisingly late), carefully cultivate and scratch in the first of 2 organic fertilizer meals for the season. Fertilize again before bloom; avoid excessive nitrogen applications. Mulch with several inches of compost or finely shredded bark to keep the soil cool. Water during dry spells. Stake tall lilies and deadhead after bloom. After the tops die, cut the stems down to a few inches to mark the spot for next year. Clear away faded foliage and plant debris to remove overwintering pests and diseases.

Move or divide lilies only when overcrowding makes it absolutely necessary; their fragile bulbs and fleshy roots resent any disturbance. Dig bulbs after stalks die back; replant immediately or wrap them in a plastic bag of barely moist perlite to keep the roots from drying out, and store in a cool place. Discard any

bulbs that appear diseased or damaged. Expect minimal growth the first year after transplant. Small bulbils or bulblets may form in leaf axils or near the base of stalks; harvest and plant these at the end of the growing season to produce new plants.

Problems

Leaves yellow; plant wilts; bulbs decay. Cause: Bacterial or fungal rots. Control these rots with proper culture: Plant lilies in well-drained soil; select a site with good air circulation; avoid excess water in the soil or on foliage; dig and cultivate with care to prevent injury to bulbs.

Leaves yellow or distorted; bulbs decayed. Cause: Bulb mites. These mites are especially problematic when bulbs are injured by careless digging or cultivation. See "Leaves yellow or distorted; bulbs decayed" on page 50 for controls.

Leaves, stems, and buds distorted, sticky; clusters of small insects. Cause: Aphids. Several species of aphids attack lilies, damaging plants by feeding and also by transmitting viral diseases. Use a strong spray of water to knock aphids from plants; do this early in the day to allow time for leaves to dry before nightfall. Encourage beneficial insects such as lacewings and lady beetles. Sprays of insecticidal soap may give control; treat severe infestations with neem or pyrethrin.

Leaves with orange or reddish brown spots; buds rotted. Cause: Botrytis blight. This most common disease of lilies progresses from leaf spots to limp, blackened foliage starting with the lower leaves and moving up. Distorted flowers may have brown flecks. In wet weather gray mold forms on blighted plant parts—the disease is also called gray mold. Fungus spores are present in most soils and are activated by cool, wet conditions.

Some lily species and cultivars are more resistant to Botrytis than others, but this information is not always readily available. Choose resistant lilies, if identified, when buying bulbs; otherwise rely on good culture and healthy plants to limit disease. For tips on buying healthy bulbs, see the illustration on page 49. In fall, clean up debris where spores overwinter. Thin plantings to encourage good air circulation. Remove and destroy infected plants and plant parts. Spray weekly with a copper fungicide until the disease is under control.

Leaves mottled; plant stunted. Cause: Viral diseases. A variety of viruses cause yellowed, mottled, or streaked leaves and stunted stems on lilies. Flowers may be discolored. Aphids and other sucking insects carry viruses from infected lilies or from carriers, such as tiger lilies, that show no disease symptoms. Tulips and cucurbits also carry viruses that affect lilies. Infected plants eventually wilt and die.

There is no cure for viral diseases. Remove and destroy infected plants immediately. Wash tools and hands after working around diseased plants. To limit the spread of viruses, routinely check lilies for aphids, and control the pests if necessary; see "Leaves, stems, and buds distorted, sticky; clusters of small insects" above for control measures. Buy bulbs and plants from reputable sources—some will certify stock as "virus-free." Do not plant lilies in sites where diseases have occurred on bulbous plants. Separate lilies from tulips, cucurbits, and wild lilies.

Leaves pale above with dusty blisters on undersides. Cause: Rust. Powdery pustules on leaves' lower sides correspond to pale areas on the upper surfaces. Provide good air circulation around foliage; avoid wetting leaves when watering. Remove infected leaves; cut plants back in fall and dispose of leaves and stems. Dust or spray leaves with sulfur beginning early in the season to prevent rust or to treat a mild infection.

Shoots disappear or do not emerge.

Cause: Animal pests. Deer and groundhogs relish lily shoots; rodents enjoy the bulbs. Plant lilies where regular human activity will discourage wildlife; pet cats or dogs also deter animal pests. Line planting beds with hardware cloth to exclude burrowing rodents; cover beds with screen wire in winter. Experiment with repellents such as dried blood, human hair, or garlic sprays. Some gardeners use a few musky-smelling fritillary bulbs planted among the lilies to repel animal pests. Keep flower beds free of brush and plant debris, which offer shelter to hungry wildlife.

Liquidambar

Sweet gum. Trees.

Sweet gums are native deciduous trees bearing alternate, star-shaped leaves that turn brilliant scarlet in autumn. While a handsome tree for the large lawn, sweet gum is intolerant of air pollution and is a poor choice for urban sites.

Set out in spring as balled-and-burlapped plants, in full sun. A deep, slightly acid, moist soil of average fertility is best. Allow plenty of room for the tree's extensive root system. The plants are slow to establish; a thick layer of mulch and regular watering for the first few years will promote root development. Once they settle in, sweet gums are fairly problem-free.

Problems

Leaves skeletonized or with large holes; branches may be webbed. Cause: Caterpillars. See "Leaves skeletonized or with large holes; branches may be webbed" on page 236 for controls.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. For controls, see "Leaves yellow; stems and leaves covered with small bumps" on page 237.

Trunk or branches with sunken, oozing areas. Cause: Bleeding necrosis. It is natural for the tree to exude some sticky "gum" from the trunk as it grows. However, excessive amounts of sap from dark, sunken areas in the bark may indicate a disease problem; left unchecked, it can quickly kill the tree. Cut out diseased areas as soon as you find them.

Plant defoliated; branches bear cocoonlike bags. Cause: Bagworms. See "Plant defoliated; branches bear cocoonlike bags" on page 236 for control measures.

Liriodendron

Tulip tree, yellow poplar. Trees.

Tulip trees are tall-growing with alternate, 3-lobed leaves. Yellow flowers appear near the top of the tree in late spring or early summer. Tulip tree makes a fine specimen tree for large properties.

Set out in spring as a balled-and-burlapped plant. Full sun and slightly acid, deep, well-drained but moisture-retentive soil suits it best.

Problems

Leaves wrinkled and discolored. Cause: Aphids. The small green tuliptree aphid can be abundant on the undersides of leaves, secreting copious amounts of honeydew. For control information, see "Leaves wrinkled and discolored" on page 235.

Leaves yellow and drop early. Cause: Lack of water. Leaf yellowing is a common problem on newly planted trees as well as established

ones that don't get enough water. Avoid by watering during dry periods and using a thick layer of organic mulch.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. See "Leaves yellow; stems and leaves covered with small bumps" on page 237 for controls.

Leaves with spots. Cause: Tuliptree spot gall. Circular brown or purple spots surrounded by a circle of yellow on the leaves reveals the presence of tuliptree spot gall, caused by a kind of midge. Damaged leaves may fall early. While unsightly, the problem is not serious and is best countered by removing all affected fallen leaves.

Leaves with powdery white coating. Cause: Powdery mildew. See "Leaves with powdery white coating" on page 237 for controls.

Lobelia

Lobelia. Perennials.

Lobelia's numerous species of annual and perennial flowers offer gardeners a broad array of plant heights and flower types. Cardinal flower (*Lobelia cardinalis*), perhaps the best-known species, features spikes of brilliant red, 3-lobed flowers that hummingbirds find irresistible. Other species bear star-shaped blooms in shades of blue and lavender; lobelias with red or bronze foliage are also available. Plants grow 2′-5′ tall with a spread of about 2′.

Lobelias prefer shady sites where the soil is consistently moist but well-drained. Plants tolerate full sun in cool climates, if ample moisture is provided, but generally need at least partial shade to thrive. Summer mulch helps retain much-needed soil moisture; a light winter mulch helps protect crowns. Renovate plantings of these short-lived perennials by division or reseeding every 2-3 years. Cover seeds lightly to keep them from drying out.

A number of pests may feed on lobelias, but damage is rarely significant enough to require treatment.

Problems

Leaves, stems, and buds distorted, sticky; clusters of small insects. Cause: Aphids. Aphids are sometimes troublesome; see "Leaves, stems, and buds distorted, sticky; clusters of small insects" on page 177 for control information.

Leaves with rotted patches or spots. Cause: Fungal rots; leaf spots. The moist soil conditions favored by lobelias encourage a variety of fungal rots and leaf spots that are best treated culturally. Remove infected plants and plant parts; keep gardens free of plant debris and weeds where diseases can overwinter; space plantings to permit good air circulation.

Lobularia

Sweet alyssum. Annuals.

Alyssums are popular, mound-forming plants that bloom from spring until frost. Plant size is 3″-8″ high and to 10″ wide. Flowers are pink, purple, or white and appear in multiple ¾″ clusters. In numbers, the sweet honey smell of alyssum reminds some gardeners of fresh-mowed hay. Bees like the aroma, too; use alyssum near fruit trees that need pollinating. Alyssum is ideal for borders or as groundcovers for small areas.

Alyssum likes full sun and well-drained average soil. Direct-sow in loose soil 5 weeks before last frost. Do not cover seeds; they

require light to germinate. Seedlings appear within 2 weeks. Thin to 5″ apart; cut, rather than pull out, to avoid damage to intertwined roots of other seedlings. Plants may flower within 6 weeks of seeding.

Water regularly for best growth, even though alyssum can tolerate temporary drought. Use a general-purpose fertilizer once in spring. Excess fertilizing gives ample foliage but few flowers. Flowering mounds tend to become sparse and rangy toward midsummer; shear the plants back and they will resume blossoming.

Problems

Seedlings die. Cause: Damping-off. For control information, see "Seedlings die" on page 20.

Stems and roots rot. Cause: Fungal wilt. Lower leaves and stems of mature alyssum will rot; white fungal strands may be visible around the plant base. Plants growing in well-drained soil are less susceptible. Discard damaged plants. To avoid transferring the fungus to healthy plants, wash your hands and gardening tools after handling infected plants.

Lonicera

Honeysuckle. Shrubs and vines.

Honeysuckles are alternate-leaved shrubs and vines. They bear usually fragrant flowers that give way to colorful fruit.

Plant honeysuckles in spring or fall in sun or partial shade. They can tolerate a range of soil conditions, but moist, well-drained sites suit them best.

Problems

Leaves wrinkled and discolored. Cause: Aphids. See "Leaves wrinkled and discolored" on page 235 for control measures.

Leaves with powdery white coating. Cause: Powdery mildew. For controls, see "Leaves with powdery white coating" on page 237.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. See "Leaves yellow; stems and leaves covered with small bumps" on page 237 for controls.

Leaves rolled and chewed. Cause: Leafrollers. These ½″, green-bodied, brown-headed caterpillars form small webs on shoot tips and feed on leaves and buds inside. Break open webs and handpick larvae; spray BTK at the first sign of damage.

Leaves with sunken, discolored spots. Cause: Four-lined plant bugs. These ¼″, yellow bugs have 4 black stripes on their wings. They are active in early summer. Control by handpicking; use pyrethrin on leaves for severe infestations.

Trunk or branches with oozing lesions; branch tips die back. Cause: Canker. See "Trunk or branches with oozing lesions; branch tips die back" on page 238 for controls.

Plant defoliated. Cause: Honeysuckle sawflies. The 1″, gray-and-yellow caterpillar-like larvae feed ravenously on foliage. Handpick, or spray shoots with insecticidal soap; use pyrethrin as a last resort.

Lupinus

Lupine. Perennials.

Two-foot-long stalks, thick with blue, yellow, rose, cream, or bicolored, ½″-1″, pealike flowers make lupine plantings early summer showpieces. Bright or grayish green, palmlike, compound leaves add a tropical effect.

Several species occur worldwide, but cultivars, especially the Russell hybrids, are favored for the array of colors and color combinations they offer. Plants range from 1½′ to 3′ tall and form 2′ wide clumps.

Lupines are best adapted to areas where summers are cool and not too dry. They suffer in heat, but serve well as annuals where conditions are not optimal. Full sun and moist, well-drained, neutral to acidic soil promote healthy growth. Water and mulch to keep soil moist. Lupines are short-lived, but can be perpetuated through division. Self-sowing also occurs, but seedlings often have different colors than the parent plants.

Lupines attract their share of pests and diseases, although most problems stem from unfavorable growing conditions. Aphids and powdery mildew may appear; see "Leaves, stems, and buds distorted, sticky; clusters of small insects" and "Leaves covered with white powder" on page 177 for controls.

Magnolia

Magnolia. Trees.

Magnolias are alternate-leaved, deciduous or evergreen trees with bold leaves; conspicuous, cup-shaped flowers; and interesting bright red fruit. They make beautiful specimen or accent plants.

Set out in spring as balled-and-burlapped plants. Magnolias grow well in full sun or light shade. They prefer moist soil enriched with organic matter.

Problems

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. Scale insects are the chief enemy of magnolias. For control measures, see "Leaves yellow; stems and leaves covered with small bumps" on page 237.

Blossoms brown and limp. Cause: Frost damage. The flowers of early blooming magnolias are often subject to frost damage. Avoid planting sites with southern exposures, which can encourage buds to open while there is still danger of frost. Or plant later-blooming species or cultivars.

Leaves discolored, wilted, or dropping; lacking vigor. Cause: Mealybugs. The tiny, powdery white adults generally congregate on the trunks and interior branches, making them difficult to see until the plant starts to weaken. Control by spraying the plant (especially the bark) with superior oil or repeated applications of insecticidal soap.

Leaves stippled with yellow; foliage webbed. Cause: Spider mites. See "Leaves stippled with yellow; foliage webbed" on page 236.

Trunk or branches with oozing lesions; branch tips die back. Cause: Canker. For more details, see "Trunk or branches with oozing lesions; branch tips die back" on page 238.

Leaves with spots. Cause: Leaf spots. See "Leaves with spots" on page 237 for controls.

Mahonia

Mahonia, holly grape. Shrubs.

Mahonias are broad-leaved, evergreen shrubs. They are used for hedges, foundation plantings, and shrub borders.

Set out in spring as balled-and-burlapped or container-grown plants. Choose a partially shaded location to avoid winter leaf burn. Almost any good, well-drained garden soil will suit them; moist, acid soil is ideal.

Problems of mahonias are few and relatively unimportant. Barberry aphid, a small yellowish green insect, can be abundant on the West Coast; see "Leaves wrinkled and discolored" on page 235 for controls. Scale insects can attack twigs and sometimes foliage; for control information, see "Leaves yellow; stem and leaves covered with small bumps" on page 237.

Malus

Apple, crab apple. Trees.

Apples and crab apples are trees with alternate, deciduous leaves. They produce beautiful spring flowers and attractive red or yellow fruit. Apples are common in home orchards. Crab apples are valued as specimen trees; smaller species can be used in shrub borders. Birds are fond of crab apple fruit.

Plant in spring in moist but well-drained soil in full sun. They adapt well to a range of soil conditions. To avoid removing the following year's flower buds, it is best to prune soon after flowering. Keeping the center of the plant open to light and air will help reduce disease problems. Crab apples commonly produce suckers from the roots; cut these shoots down to the ground as soon as you see them.

Pests and disease problems on apple trees are covered in the Apple entry beginning on page 21. Crab apples share many of the same problems, including fire blight, cedar-apple rust, powdery mildew, and apple scab. Fortunately, disease-resistant cultivars are available. Some of the best include 'Adams', with reddish pink flowers; 'Coral Cascade', with white flowers; 'Prarifire', with purplish red flowers; and 'Professor Sprenger', with white flowers. There are also many other resistant cultivars, so check with your local nursery owner or extension agent to learn about the best ones for your area.

Be aware that even resistant cultivars may have problems if the conditions promoting disease are very favorable. Planting trees on sites with good air circulation and keeping trees growing vigorously are easy ways to avoid problems. For more information on crab apple pests and diseases, see the Apple entry beginning on page 21.

Melon

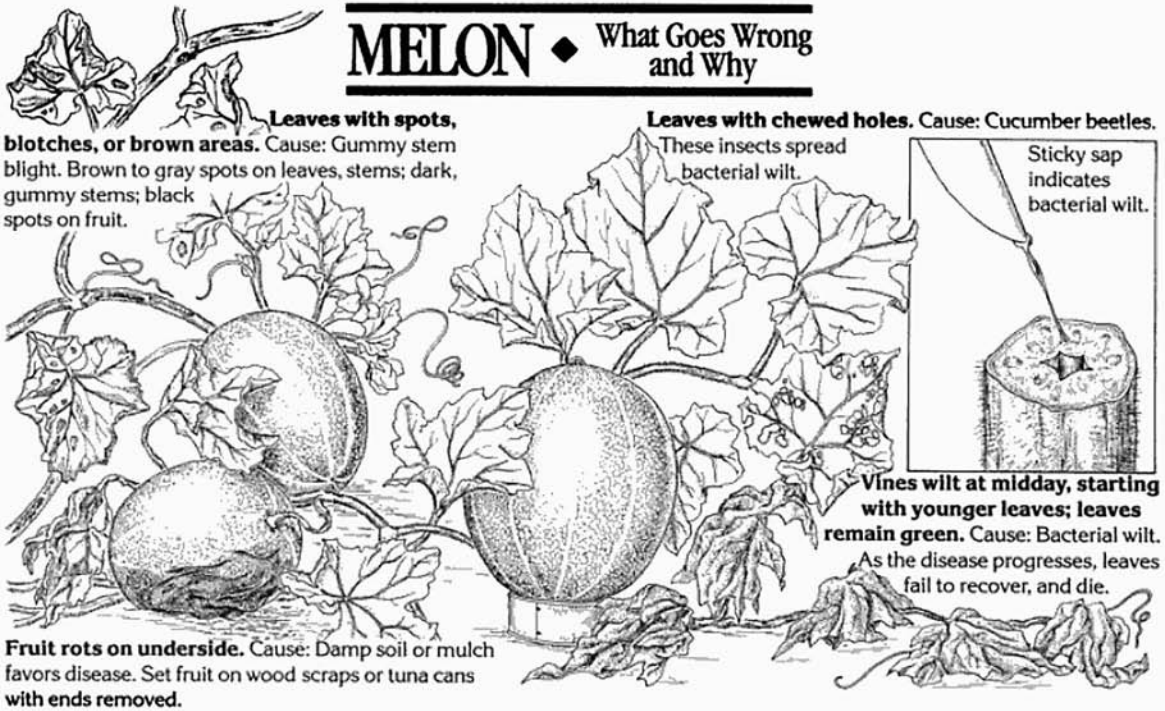
Cucumis melo and other genera
(Cucurbitaceae)

Melons can be challenging to grow, especially in cooler climates. But if you have the patience, there is nothing more satisfying than a fragrant, sun-ripened melon.

Culture

Melon seeds need 60°F soil to germinate. In northern areas start plants indoors 2-3 weeks before the last frost date and transplant outside once temperatures are reliably warm. Melons need lots of sunlight and warm temperatures—90°F is ideal. Melons are especially vulnerable to pests and cool temperatures when plants are young. Plants exposed to temperatures below 50°F can be permanently injured and fail to set fruit. Cover plants with floating row cover or clear plastic tunnels as soon as they are set out. If temperatures exceed 90°F inside the tunnels, vent them by making a 6″ cut in the plastic directly over each plant. Remove row cover when melons begin to flower so insects can pollinate the blossoms, or you will not get any fruit. In the fall temperatures below 50°F cause cold stress and rapid wilting. Cover plants on cool nights.

Melons do best in well-drained, loose-textured soils with lots of organic matter. They prefer a pH between 6.0 and 6.8, but can


MELON ◆ What Goes Wrong and Why
Leaves with spots, blotches, or brown areas. Cause: Gummy stem blight. Brown to gray spots on leaves, stems; dark, gummy stems; black spots on fruit.
Leaves with chewed holes. Cause: Cucumber beetles. These insects spread bacterial wilt.
Sticky sap indicates bacterial wilt.
Vines wilt at midday, starting with younger leaves; leaves remain green. Cause: Bacterial wilt. As the disease progresses, leaves fail to recover, and die.
Fruit rots on underside. Cause: Damp soil or mulch favors disease. Set fruit on wood scraps or tuna cans with ends removed.

tolerate a pH as high as 7.6. Melons are shallow-rooted and may wilt on hot, dry days even when they are not diseased. Keep them well-watered, but do not let the soil become saturated. Wet soil can cause stems to rot at soil level. Overwatering, or uneven watering, can cause fruit to split. Potassium deficiency can also cause split fruit.

Prevent disease problems by keeping the leaves dry. Water carefully or use drip irrigation. Mulch melons to help conserve water: Black plastic is a good choice for central and northern areas, but in extremely warm areas it can warm the soil too much. Organic mulches are good, too, but also provide shelter for pests like squash bugs.

To reduce problems, rotate crops so that no member of the cucurbit family (squash, cucumbers, or melons) is grown in the same place more often than every 4 years.

The opposite page illustrates some insects and diseases that attack melons.

Caution: Melon leaves are easily burned by insecticidal soap and copper sprays. Use the most dilute spray recommended and apply sparingly. Do not spray plants in direct sun, or if temperatures are above 80°F, and don't spray drought-stressed plants.

Leaf and Vine Problems

Leaves with chewed holes. Cause: Cucumber beetles. Adults are ¼" long, greenish yellow beetles with black stripes or spots. They attack young leaves and should be controlled immediately, as they spread bacterial wilt or viruses. Treat plants with a commercial pyrethrin spray or dust.

Leaves with pale green patches; afflicted leaves wilt and blacken. Cause: Squash bugs. Adults are brownish black, ½" long bugs. Immature bugs are whitish green with dark heads and legs. Both emit a strong, sharp smell when crushed. Eggs are bright orange and are laid on the undersides of leaves. Handpick adults and eggs. Trap bugs by placing a board on the ground near plants. Lift it each morning and destroy the squash bugs hiding underneath.

Leaves with yellow patches; older leaves mottled and distorted. Cause: Mosaic. For an illustration of this virus, see page 214. Afflicted plants are unproductive and fruit is bitter. Remove and destroy diseased plants. Control aphids and cucumber beetles, because they spread the virus.

Leaves yellow, curled, and wilted. Cause: Aphids. Look for small, green, pink, gray, black, or white fluffy-coated, soft-bodied insects feeding on plants. Aphids can also transmit viral diseases. Control them by knocking them off the plant with a blast of water, or use with a weak insecticidal soap spray; see the caution above before spraying. Use foil mulch to keep aphids from finding plants.

Leaves yellow and puckered, becoming bronzed. Cause: Mites. These tiny, red, yellow, or green, spiderlike creatures are worst in dry, hot weather. In severe cases leaves dry out and drop off. There may be a fine webbing on the undersides of leaves. Spray plants with a weak insecticidal soap spray to control; see the caution above before spraying.

Leaves mottled yellow between veins; leaf undersides have purple spots. Cause: Downy mildew. As the disease progresses, older leaves turn brown and die, and younger leaves become infected. Treat plants with a dilute solution of copper spray to reduce the spread of the disease; see the caution above before spraying. Prevent problems by planting resistant cultivars such as 'Morning Dew', 'Saticoy', and 'Tam Honeydew'.

Leaves with powdery white spots, especially on upper surfaces. Cause: Powdery mildew. As the disease progresses, leaves turn brown and dry, and plants may die. Treat plants with a dilute solution of copper spray to reduce the spread of the disease; see the caution above before spraying. Prevent problems by planting resistant cultivars such as 'Hales Best Jumbo', 'Quick Sweet', and 'Starship'.

Leaves with spots, blotches, or brown areas. Causes: Alternaria leaf blight; anthracnose; angular leaf spot; scab; gummy stem blight; other fungal and bacterial diseases. Various diseases attack melons. Reduce problems by keeping the foliage dry when watering and by not touching plants when wet. Spray infected plants with a dilute solution of copper spray to control outbreaks; see the caution on page 149 before spraying.

Dark brown spots with concentric rings, usually appearing on older leaves first, are caused by Alternaria leaf blight. As the disease progresses, leaves curl down and eventually drop off. Fruit infected with this disease has brown, concentrically ringed, sunken spots. Prevent problems by planting resistant cultivars such as 'Earligold', 'Pulsar', and 'Saticoy'.

Yellow spots that turn brown are caused by anthracnose. Infected leaves eventually die. This disease causes fruit with circular black cankers. Prevent problems by planting anthracnose-resistant muskmelon cultivars, such as 'Passport', and resistant watermelon cultivars, such as 'All Sweet', 'Crimson Sweet', 'Dixie Lee', and 'Sweet Favorite'.

Water-soaked spots that turn gray, die, and drop out leaving shotholes are caused by angular leaf spot or scab. Fruit infected with angular leaf spot has small, cracked, white spots. Scab causes fruit with sunken, brown spots with a gummy ooze, and damage is worst in cool, moist weather. Pale, round leaf spots with dark margins are caused by Cercospora leaf spot.

Brown to gray spots on leaves and stems, and dark, gummy stems are caused by gummy stem blight. Infected leaves turn yellow and die. Disease begins as spots on stems, which become streaks; stems then turn dark and gummy. When it attacks fruit, the disease is called black rot: Infected fruit has round, black spots and the fruit flesh collapses. For an illustration of this disease, see page 148.

Vines wilt suddenly. Cause: Squash vine borers. Check for fat, white, 1″ long larvae burrowing into stems, and masses of yellow-green, sawdustlike excrement. Slit stems lengthwise above injury with a sharp knife and kill larvae. Cover cut stems with moist soil so they will form new roots. Injecting stems with BTK or parasitic nematodes may also control borers. Spraying stem bases with BTK once a week in late spring and early summer may prevent damage.

Vines wilt at midday; leaf margins brown. Cause: Fusarium wilt. As the disease progresses, vines fail to recover, and die. Destroy infected plants. Prevent problems by planting resistant muskmelon cultivars, such as 'Pulsar', 'Saticoy', 'Savor', and 'Starship', and resistant watermelon cultivars, such as 'All Sweet', 'Crimson Sweet', 'Dixie Lee', and 'Sweet Favorite'.

Vines wilt at midday, starting with younger leaves; leaves remain green. Cause: Bacterial wilt. As the disease progresses, leaves fail to recover, and die. Cut wilted stem and touch the tip of your knife to the sap. If it is milky, sticky, and astringent, your plant is infected. For an illustration of this disease and technique, see page 148. Destroy infected plants immediately. Prevent problems by controlling cucumber beetles, since they spread the disease.

Fruit Problems

Fruit with spots; flesh may rot. Causes: Angular leaf spot; Alternaria blight; scab; black rot; anthracnose. Several fungal and bacterial diseases cause these symptoms on melon fruit. For complete symptoms, controls, and resistant cultivars, if available, see "Leaves with spots, blotches, or brown areas" above.

Fruit flesh not sweet. Causes: Premature harvest; overwatering; nitrogen deficiency. Harvest muskmelons and honeydews when they smell ripe and the stem separates easily from the vine when the fruit is gently lifted. Harvest watermelons when the bottom of the fruit turns from pale yellow to golden yellow. Excess rain or irrigation while fruit is swelling

can dilute sugars. Keep soil evenly moist throughout the season. If leaves are small and yellow, and growth is stunted, plants are nitrogen starved. Spray foliage and drench roots with fish emulsion.

Fruit rots on underside. Cause: Damp soil or mulch. To prevent rot, support fruit on scraps of wood, or tuna cans with ends removed. See page 148 for an illustration of this technique.

Mertensia

Bluebells. Perennials.

Native Virginia bluebells (*Mertensia virginica*) seem to materialize from the floors of eastern forests in early spring. Clusters of pink buds that open to tubular blue flowers are carried on graceful stems over rounded, medium green foliage. Plants grow 1′-2′ tall and spread to about 1′ wide.

Rich, moist, well-drained soil and partial shade are bluebells' requirements. Plantings increase slowly but steadily in sites that resemble their woodland habitat. Leaves yellow and die back in summer; plants seem to have disappeared by July. Do not cut fading foliage; allow it to die back naturally. Root rot may damage bluebells in poorly drained soil; they are otherwise trouble-free.

Mint

Mentha spp. (Labiatae)

Mints are hardy (Zone 5) perennial herbs grown for their fragrant leaves. They are usually grown from cuttings. Plant in rich, moist, well-drained soil with a pH between 5.0 and 7.5, in full sun or part shade.

Mints are vigorous, trouble-free plants. They can be quite invasive once established. Let them take over a wild area or plant them in containers or in bottomless buckets sunk into the garden to prevent them from spreading.

Fungi can cause dark, sunken spots on leaves. Spray foliage with fish emulsion, or with sulfur if disease is severe. Tan to red blisters on leaves are caused by rust. Avoid wetting leaves to prevent its spread. Pale stippled or bronzed leaves are caused by mites—tiny, spiderlike creatures that thrive in hot, dry weather. Spray with insecticidal soap. See the Herbs entry beginning on page 116 for other possible problems.

Monarda

Bee balm. Perennials.

Brightly colored, spidery flower heads and dense, dark green, aromatic foliage attract gardeners to these native plants. Hummingbirds, bees, and butterflies are also drawn to bee balms' blossoms, especially the red ones. Plants form dense clumps, 2′-5′ tall and 3′ wide; the mintlike foliage remains attractive after flowers fade.

Found in the wild along shady stream banks, bee balms favor similar sites in the garden—consistently moist, well-drained soil and light shade. Giving such favorable surroundings, however, encourages bee balms' invasive nature; plantings can spread out rapidly. Planted in full sun, bee balms still grow nicely but are more easily controlled. Water and mulch in summer to prevent water stress, which quickly disfigures plantings. Clumps tend to die out in the center; divide every 3 years to

keep growth compact. Remove spent flower heads to prolong bloom.

Problems

Leaves covered with white powder. Cause: Powdery mildew. This fungus is almost guaranteed to appear on bee balm foliage, even under the best of conditions. Plants suffering drought or overcrowding succumb readily and are soon covered with white or grayish mildew. Don't let bee balms dry out, but avoid wetting leaves, and water early in the day so foliage can dry before nightfall. Space plantings for optimum air circulation, and keep gardens free of plant debris that may host fungal spores. Sprays of sulfur and antitranspirants help prevent powdery mildew infections; use sulfur, fungicidal soap, or garlic sprays to prevent the spread of mild infections.

Narcissus

Daffodil, narcissus. Bulbs.

Today's much-hybridized daffodils are welcome harbingers of spring. Hundreds of cultivars, classified by flower type and bloom time, blossom in shades of yellow, orange, white, and pink; many are bicolored. Each flower has a trumpet or cup-shaped center, surrounded by 6 petal-like structures; many are fragrant. Bluish green leaves are straplike and upright, 1′-1½′ long and ¾″ wide. Plants grow from 6″ to 1½′ tall, depending on cultivar.

Buy daffodils from a reputable source to ensure that you get healthy, pest-free bulbs. Look for double- or triple-"nosed" bulbs, so-named because of their multiple growing points that produce more flowers than single-nosed bulbs. Plant bulbs in fall, at least 1 month before the ground freezes. Select a site in full sun or light shade with humus-rich, well-drained soil. Set bulbs 4″-8″ deep—roughly 1½ times bulb height. A location behind annuals or perennials helps hide the yellowing foliage that remains after flowering ends. Remove spent flowers, but allow leaves to die back naturally; this lets bulbs store food for next year's floral display. Tying, cutting, or covering the leaves reduces the amount of light they receive and jeopardizes flowering in subsequent years.

Daffodil bulbs multiply gradually to form clumps. While plants will grow undisturbed for years, overcrowding eventually reduces flower size. Dig bulbs after foliage fades and shake away loose soil. Place them out of the sun to dry for a few days, then gently separate offsets from parent bulbs and replant. Small offsets may take a couple of years to bloom.

Don't worry about the animal pests that eat most other bulbs; daffodils' bitter taste deters feeding wildlife. Choose bulbs carefully to avoid most other pests and diseases; see the illustration "Buying Healthy Bulbs" on page 49.

Problems

Flowers and leaves with silvery flecks. Cause: Thrips. Flower thrips rasp daffodil leaves and flowers, causing silvery or whitish flecks; leaves eventually turn brown and die. They reproduce and spread rapidly, especially in dry areas. Other symptoms include leaf browning. These pests burrow into plant tissue and are difficult to control. Inspect bulbs carefully. Remove and destroy severely infested plant parts. Use blue sticky traps to monitor and trap pests. Applications of insecticidal soap may provide some control once pests are spotted in traps.

Leaves with white or brown streaks; foliage wilted. Cause: Viral decline. Plants suffering from viral decline develop white or brown

streaks on the leaves late in their growing season. Foliage may wilt and topple over. There is no cure for decline. Remove diseased plants. Control aphids, which spread decline and other viral diseases; for control techniques, see "Leaves, stems, and buds distorted, sticky; clusters of small insects" on page 51.

Plant fails to appear; bulbs soft. Cause: Bulb flies. Narcissus bulb flies resemble small bumblebees; lesser bulb flies are ⅓" long, blackish green flies. Both lay their eggs at the base of bulb leaves; larvae hatch and bore into bulbs to feed—usually 1 maggot per bulb in the case of narcissus bulb flies and several per bulb in the case of lesser bulb flies. Their holes admit rot organisms into bulbs. Discard infested bulbs. If bulb flies are a problem in your area, try covering plants with floating row cover during the egg-laying period (late spring). Treat plants weekly with a commercial pyrethrin dust if pests have been a problem in past years.

Plant stunted; flowers deformed. Cause: Basal rot. Infection by Fusarium basal rot causes the base of the bulb to turn soft and brown. The rot spreads up through the bulb. Infected plants are stunted and have few flowers. Dig and destroy bulbs that show signs of disease. Avoid injuring bulbs during planting or cultivation; fungi most often infect bulbs through wounds.

Plant fails to grow and/or flower; leaves with swollen spots. Cause: Bulb and stem nematodes. Feeding by microscopic roundworms causes deformed leaves with yellow-green spots and small, swollen areas. Bulbs develop dark internal circles or blotches and may fail to grow or bloom in spring. Dig and destroy severely infected bulbs and foliage. Soak mildly infested bulbs in hot (110°F) water for 3 hours, then plunge them immediately into cold water. Let them dry and store in a cool, dark place until fall when they can be replanted. Solarize infected soil or treat with a chitin source.

Nicotiana

Flowering tobacco. Annuals.

For both fragrance and color, nicotiana belongs in every summer garden. Clusters of sweetly fragrant, starlike, tubular flowers appear in red, pink, lime, lavender, or white. Group these 1'-3' tall plants together for best showing. Older kinds bloom in evening only, but new offerings bloom in daylight. Night-blooming whites are most fragrant; day-blooming cultivars are much less fragrant. New blossoms open each day to replace spent ones.

Sow seed indoors in April; bottom heat will speed germination. Or, direct-seed outdoors in late spring. Do not cover very small seeds, which need light to germinate. Seedlings appear within 3 weeks and grow rapidly. Thin or transplant to 9" apart. Nicotiana grows best in average soil in full sun or partial shade. Water well during hot, dry weather. Give less fertilizer and water in late summer to keep plants blooming longer. Nicotiana self-sows but may not come true to color.

Do not grow nicotiana in dusty areas; the sticky, fuzzy leaves attract and hold dirt. Also, do not plant near tomatoes. Nicotianas may attract insect pests and diseases that seldom seriously bother this hardy plant, but will quickly move on to any nearby tomatoes.

Problems

Leaves, stems, and buds distorted. Cause: Aphids. For controls, see "Leaves, stems, and buds distorted" on page 20.

Leaves yellow; plant weakened. Cause: Whiteflies. See "Leaves yellow; plant weakened" on page 18 for controls.

Seedlings or young plants cut off at soil level. Cause: Cutworms. For control measures, see "Seedlings or young plants cut off at soil level" on page 20.

Okra

Abelmoschus esculentus (Malvaceae)

Okra is an annual vegetable grown for its fleshy seed pods. Okra does best in loose, well-worked soil with a pH between 6.0 and 7.0, and full sun. It needs lots of phosphorus, so work in plenty of bonemeal and compost before planting.

Okra grows best at temperatures between 70° and 85°F and does not tolerate temperatures below 60°F.

Warm soil at planting time is very important. Wait until the soil is at least 60°F before planting. Okra does not germinate well and is more susceptible to pests in cooler soil. If you have cool soils with high clay content, cover the planting area with clear plastic to warm up the soil at least 2 weeks before you want to plant. Cover planted seeds with clear plastic or row cover for a few weeks to give them a good start. Remove the clear plastic as soon as seeds germinate to avoid damaging the seedlings. Okra does well with black plastic mulch because it warms the soil.

Okra is susceptible to several common vegetable crop problems, including damping-off, aphids, fungal wilts, leafminers, and mites. See the Vegetables entry beginning on page 245 for symptoms and controls.

Problems

Leaves turn yellow, wilt, and fall off; stem rotted at soil line. Cause: Southern blight. White to pink fungal growth may spread over the soil around the base of infected plants. Severely infected plants die. Destroy infected plants and dig out and dispose of the top few inches of soil within 6″ of the stem. Adding lots of compost to the soil helps prevent this disease.

Plant yellow and stunted, wilts during bright, hot days; roots have swollen galls. Cause: Root knot nematodes. Galls may be up to 1″ in diameter. Destroy infected plants. Control pest nematodes by adding chitin and parasitic nematodes to the soil.

Buds, flowers, and seed pods malformed and drop prematurely. Cause: Stink bugs. Seed pods may have hard, callused bumps. Adults are flat, shield-shaped, green, blue, or red insects that emit a sharp odor when crushed. Handpick these pests to control mild infestations. Spray plants with pyrethrin if injury is serious.

Flowers turn brown; seed pods rot. Causes: Choanephora blight; gray mold. Infected parts may be covered with white or gray growth. Spray plants with compost tea as soon as plants start to bloom and repeat every few weeks to help prevent these fungal diseases, or with sulfur to keep mild infections from spreading.

Seed pods with chewed holes. Cause: Caterpillars. Leaves may also have holes. Handpick or spray plants with BTK if you see caterpillars.

Seed pods pitted, discolored, or with water-soaked areas. Cause: Cold injury. Prevent damage by protecting plants with row cover when cold nights are expected.

Onion

Allium cepa and other species
(Liliaceae)

Onions are biennial vegetables grown for their sweet to pungent bulbs and greens. Dried or fresh, raw or cooked, onions are an indispensable ingredient in a variety of soups, salads, breads, and casseroles.

Culture

Onions grow best in full sun and deep, fertile, well-drained soil with lots of organic matter. Work in a generous amount of compost before planting. Onions need high levels of nitrogen and potassium and moderate to high levels of phosphorus, so do a soil test and amend soil as needed before planting. Onions grow well in raised beds or ridges, especially if soil is clayey.

Onions grow best between 55° and 75°F, and will tolerate temperatures as low as 45° and as high as 85°F. They prefer cool temperatures early in their growth and warm temperatures near maturity.

Keep the soil moist since onions have shallow roots, but don't allow soil to become saturated because onions are susceptible to several root rot diseases. Mulching onions with composted leaves or straw is highly recommended to maintain soil organic content, help prevent disease, and keep down weeds. Wait until soil warms to apply mulch.

To help prevent populations of disease organisms from building up in the soil, avoid planting onions where onion family members have been grown during the previous 3 years. In general, white onions are more prone to problems than yellow or red ones.

You can grow onions from seeds, transplants, or sets. Discard any diseased sets or transplants. Soak sets, roots, or seeds in compost tea for 15 minutes before planting to help prevent disease. Dust the roots of sets and plants with bonemeal after soaking and before planting to give them a good start.

Onion bulb formation is controlled by day length, so selecting suitable cultivars for your area is crucial. In the North choose "long-day" cultivars, and in the South choose "short-day" cultivars.

Allow tops to fall over naturally, then pull bulbs and let them air-cure for 2 weeks. After curing, sort out damaged bulbs and those with thick necks and put aside for immediate use. Store others at temperatures just above 32°F.

Plant and Leaf Problems

Seedlings fall over. Cause: Damping-off. Prevent problems by planting in raised beds and presoaking seed in compost tea.

Plant wilts rapidly. Cause: Cutworms. Check for a hole in the stem at or just below the soil line and fat, 1"-2" long, dull brown or gray caterpillars in the soil near the base of plants. Sprinkle moist bran mixed with BTK on the soil surface in the evening, or add parasitic nematodes to the soil at least a week before planting to control them.

Plant stunted; leaves may be yellow. Causes: Nitrogen deficiency; waterlogged soil; aphids; pink root. Onions need ample nitrogen, deficient plants are pale and grow slowly. Waterlogged soil damages roots and produces the

same symptoms. Spray plants and drench roots with fish emulsion or fish-meal tea to alleviate symptoms. Plant in raised beds to improve drainage and add compost before planting to prevent problems.

Aphids are soft-bodied, pale green, black, gray, pink, or white fluffy-coated, sucking insects. Check for them on young leaves. For mild infestations, knock the pests off the plants with a blast of water. Spray plants with insecticidal soap to control them, or with a commercial neem or pyrethrin spray if infestation is severe.

If roots and bulb are pinkish, the plant has pink root. Roots infected with this fungal disease shrivel and die. Destroy infected plants. Prevent problems by ensuring good drainage and adding ample organic matter to the soil. Plant resistant cultivars such as 'Crystal Wax Pickling', 'Early White Supreme', 'Hybrid Big Mac', 'J K Special', 'Tokyo Long White', 'Uno Grande PPR', and 'Voyager'.

Plant yellow and wilted. Causes: Fusarium bulb rot; onion maggots; lesser bulb flies; wireworms. Onions infected with Fusarium bulb rot have soft necks, and entire bulbs may be soft and brown. Destroy infected plants. Prevent problems by planting cultivars, such as 'Long White Summer Bunching', 'Northern Oak', 'Sentinel', and 'Valiant', that are somewhat resistant.

Onion maggots feed on roots, killing seedlings and older plants. They also burrow into bulbs, making them unfit for use. Onion maggots are ¼" long, white, and taper to a point at the head. Adults are small gray flies that lay eggs early in the spring. Destroy infested plants. Do not compost them; onion maggots thrive in compost piles. To prevent problems, apply parasitic nematodes to the soil before planting and cover plants with row cover as soon as they come up to prevent flies from laying eggs. Trap maggots by planting a few onions at scattered points around the garden a few weeks before the main planting date. These larger plants attract egg-laying adults, remove and destroy them when infested. 'Egyptian Tree' onions are tolerant of onion maggots. In general, white cultivars are more susceptible to maggot attack than are yellow or red cultivars.

Lesser bulb fly larvae are ½" long, wrinkled, and yellow-gray. They cause injury similar to onion maggots and are controlled the same way.

Yellow to reddish brown, slender, tough-bodied, segmented worms up to 1½" long feeding on roots and bulbs are wireworms. Adults are dark-colored, elongated click beetles. Apply parasitic nematodes to the soil before planting to control them.

Leaves with white streaks or blotches. Causes: Precipitation damage; thrips. Excessive rain or hail can spot onion leaves. Spots are various sizes, and damage doesn't spread. Maintain good air circulation and make sure soil is well-drained to minimize problems.

If leaf tips are distorted or brown, and leaves are stippled with white, look for onion thrips. Heavy infestations cause plants to wither and turn brown. Adults are tiny, slender, yellow to brown, rapidly moving, winged insects. The larvae can barely be seen with the naked eye. Thrips thrive in hot, dry weather. Trap them with sticky traps hung just above plant level. Try blue, yellow, and white traps to see which work best. Treat plants with insecticidal soap or a commercial pyrethrin spray or dust to control severe infestations.

Leaves with water-soaked or papery, white spots with vertical splits. Cause: Onion leaf blight. Leaf tips turn yellow, then brown. Spray plants with sulfur as soon as you see symptoms if weather is cool and humid. Prevent problems by planting tolerant cultivars such as 'Tokyo Long White'.

Leaves with pale green to brown spots. Causes: Downy mildew; ozone injury. Leaf tips turn yellow, then brown, and may be cov-

ered with a fuzzy mold. As the disease progresses, spots turn black with a purple, fuzzy mold, and leaves yellow and die. Downy mildew thrives in cool, humid weather and tends to stop spreading when the weather is warm and dry. Spray plants with sulfur to prevent the disease from spreading in cool, wet weather. Don't handle plants when wet to avoid spreading the disease.

Irregular areas with tiny brown flecks are caused by high levels of ozone in the air. Spray plants with seaweed extract and fish emulsion to encourage new growth.

Leaves with sunken, light-colored spots with concentrically ringed, purple centers. Cause: Purple blotch. Spots enlarge and girdle leaves, which wither and fall over. Spray plants with sulfur if disease is present to keep it from spreading. Cool soil makes plants more prone to this fungal disease. Warm soil by covering it with clear plastic for a few weeks before you plant.

Leaves with small reddish orange blisters. Cause: Rust. Leaves infected with this fungal disease may turn yellow and die. Bulbs are small. Clean up and dispose of tops to eliminate overwintering spores. One type of rust infects both onions and asparagus, so keep the 2 crops apart to prevent problems.

Leaves with black streaks filled with dark brown powder. Cause: Smut. Young plants are usually affected. Cool soil makes plants more prone to this fungal disease. Warm soil by covering it with clear plastic for a few weeks before you plant. Prevent problems by planting tolerant cultivars such as 'Evergreen Hardy White' and 'Tokyo Long White'.

Bulb Problems

Bulbs small and soft; roots pinkish or shriveled. Cause: Pink root. See "Plant stunted; leaves may be yellow" on page 155 for controls.

Bulbs rot in the ground. Cause: White rot. Bulbs may be covered with a white fluffy growth. Destroy infected plants; don't compost them. Prevent problems by providing good drainage and presoaking seeds in compost tea.

Bulbs with gray, water-soaked outer layers. Cause: Heat or cold injury. If temperatures are above 85°F, protect plants with a thick straw mulch and keep soil moist. Protect overwintering onions with mulch, or dig and store just above freezing.

Bulbs with bleached, soft patches. Cause: Sunscald. Protect onions from direct sun while curing, especially in hot weather. White cultivars are especially sensitive to sunscald.

Bulbs with thick necks that do not cure well. Causes: Potassium deficiency; seed stalk formation. Confirm deficiency with soil test and amend soil as needed before planting. Use bulbs with thick necks first.

Onions form seed stalks after any dormant period. Improperly stored sets or cultivars not suited to the day length in your area may go to seed before forming bulbs. Fluctuating temperatures or drying and wetting of soil may cause seed stalk formation. Harvest and use bulbs as soon as possible.

Bulbs with dark green or black, concentrically ringed spots. Cause: Onion smudge. This fungal disease usually appears near harvest or in storage. Destroy infected bulbs. Prevent problems by planting tolerant cultivars such as 'Downings Yellow Globe', 'Early Yellow Globe', and 'Southport Red Globe'.

Bulbs with sunken, dry, brown to black areas around neck. Cause: Neck rot. Necks of bulbs rot and gray mold develops inside bulbs. This fungal disease usually appears near harvest or in storage. Destroy infected bulbs. To prevent problems, cut back on watering as onions begin to mature, especially near harvest. Be careful not to injure bulbs while weeding or harvesting. Cure bulbs properly before storing them in a cool place.

Oregano

Origanum heracleoticum (Labiatae)

Oregano is a hardy (Zone 5) perennial herb grown for its aromatic leaves. Start oregano from cuttings or plants rather than from seed. Seedlings are quite variable and may have very little flavor. Oregano does best in average, well-drained soil with a pH between 5.0 and 8.0, and at least 4 hours of sun per day. Oregano needs little added fertilizer or water, but does like a layer of mulch to protect its shallow roots.

Oregano is usually quite trouble-free. Pale, stippled, or bronzed leaves are caused by mites—tiny, spiderlike creatures that thrive in hot, dry weather. Control them with insecticidal soap spray. See the Herbs entry beginning on page 116 for other possible problems.

P

Pachysandra

Pachysandra, spurge. Perennials.

Low-growing pachysandras top the list of durable, shade-tolerant groundcovers. These hardy, 8"-12" plants with glossy evergreen foliage spread quickly, providing excellent cover below trees and on slopes. Clusters of tiny, tubular, white flowers appear in late spring.

Plant in slightly acid, moist but well-drained soil rich in organic matter. Mature plants endure drought, but do best with about 1" of water per week. Full sun may scorch variegated cultivars; give partial to deep shade. Pachysandras compete well with taller plants and prosper in shady sites where few other plants will grow. Cut back by about one-quarter in spring to promote compact growth.

Most problems arise when plantings are stressed by drought, poorly drained soil, or overcrowding. Fungal diseases favor damp, crowded conditions; thin to improve air circulation and remove infected plants. Scale insects also prefer tightly spaced plantings, where their populations swell rapidly if unde-

terred. Spider mites infest drought-stressed plants when weather is hot and dry; water adequately and use a strong stream of water to knock pests off.

Paeonia

Peony. Perennials.

Attractive, long-lived, bushy plants that bear numerous 3″-6″ blossoms, peonies are the perennial gardener's dream come true. Early summer flowers arrive in shades of pink, red, white, and yellow amid glossy, lobed, green foliage; plants form neatly rounded clumps roughly 3′-4′ tall.

Peonies prefer full sun and moist, well-drained, richly organic soil, although light shade is tolerated and may prolong bloom in the South. A protected site limits wind damage to blossoms. Most are hardy to Zone 5 and do best in cold-winter climates.

Easy to care for in most respects, peonies are finicky about planting. Set rootstocks so that the reddish buds or "eyes" are no more than 1″-2″ below the soil surface. Mulch after the ground freezes the first winter after planting to prevent heaving. Divide roots in fall, if necessary, leaving at least 3 buds on each section. Cut stems back to below ground level in fall.

Problems

Flower buds absent. Causes: Improper planting; excess shade; immature plant; large, old crown; excess nitrogen; disturbed roots. Choose planting sites carefully; set roots at the proper depth; be patient with new plants. Do not apply high-nitrogen fertilizers. If mature peonies stop blooming, rule out other possible problems and divide if needed—division and other root disturbances also reduce bud formation.

Flower buds don't open. Causes: Late spring frost; drought; high temperatures; low soil fertility. Weather extremes notwithstanding, water adequately and feed peonies with compost or a slow-acting, general-purpose fertilizer in spring. If summer heat is the problem, plant early flowering cultivars.

Flower buds die or petals distorted. Cause: Flower thrips. These 1/25″ insects feed on buds, stem tips, and flowers, causing distortion or white, brown, or red flecks. Thrips are hard to control because they burrow into plant tissue. Remove and destroy infested plant parts. Encourage natural predators such as pirate bugs, lacewings, and lady beetles. Use blue sticky traps to monitor and trap pests. Insecticidal soap sprays may provide some control once pests appear on traps.

Stems with sunken lesions. Cause: Anthracnose. Sunken lesions with pink blisters appear on stems. Plants may die. Cultural controls such as regular fall cleanup and thinning stems to improve air circulation are effective. Treat severe problems with copper fungicide sprays.

Shoots wilt, collapse; crowns with gray mold. Cause: Fungal diseases. Several fungi cause blights or stem and crown rots in peonies. Botrytis blight causes shoots to wilt suddenly and fall over. Stem bases blacken and rot; gray mold may appear near soil; buds may wither and blacken. Flowers and leaves may turn brown and develop mold. Remove and destroy infected plant parts. Don't put manure near plant crowns; clear mulch from crowns in spring to let soil dry. Avoid overwatering and wet, poorly drained soil. If problems persist, scrape away the top 2″ of soil around plants and replace with clean sand. In spring, spray shoots with bordeaux mix.

Plant stunted; leaves yellow, spotted; roots with tiny galls. Cause: Root knot nematodes. Feeding by these microscopic pests reduces roots' ability to take up water and nutrients. Control root knot nematodes by applying chitin

or parasitic nematodes to soil. Also promote natural nematode controls by increasing soil organic matter. Drenching soil with neem may provide some control. In severe cases, remove plants, solarize the soil, and replant with nematode-free stock.

Papaver

Poppy. Perennials.

History has heaped symbolism upon the brightly colored blooms of poppies, yet these broad, crinkled flowers burst forth undeterred in spring and early summer. The diminutive alpine poppy (*Papaver alpinum*) offers 1" blooms and 8"-10" height, while Iceland poppy (*P. nudicaule*) and Oriental poppy (*P. orientale*) can exceed 1' in height and spread, with 3"-7" flowers. Deeply divided, hairy, gray-green foliage surrounds leafless flower stems, each with a single bloom.

Most poppies are very hardy and perform best in cool summers and cold winters; grow plants as annuals in warmer climates. Full sun to light shade and well-drained soil satisfy poppies' needs; established plants tolerate some drought, but soggy soil guarantees rotting of fleshy roots. Foliage dies back after flowering ends, and plants disappear by late summer. Mark the spot to avoid digging injury to roots. New leaves appear in fall. Divide every 5 years, in late summer, to maintain vigor. Poppies self-sow if allowed to set seed; seedlings may not come true to parents.

Problems

Leaves, stems, and buds distorted, sticky; clusters of small insects. Cause: Aphids. See "Leaves, stems, and buds distorted, sticky; clusters of small insects" on page 177 for controls.

Leaves with water-soaked spots; foliage and flowers blacken. Cause: Bacterial blight. Infected plants turn brown and lose leaves; girdled stems die. Dig and destroy infected plants and surrounding soil. Solarize soil before replanting with disease-free seed; water early in the day so leaves dry quickly.

Parsley

Petroselinum crispum (Umbelliferae)

Parsley is a biennial herb grown as an annual for its leaves. Sow seed outdoors once the soil has reached 50°F; it takes 3 weeks to germinate. Plant in cool, moist, well-drained soil with a pH between 5.0 and 8.0. It needs at least 3 hours of full sun daily.

Parsley has few problems. Handpick leaf-eating caterpillars or spray plants with BTK. Dwarfed or abnormally crinkled leaves can be caused by viruses. Destroy infected plants, and control aphids and other sucking insects that spread viral diseases. Dark, yellow-bordered spots are leaf blight caused by fungi. Spray with fish emulsion or with sulfur if disease is severe. Carrot weevils eat roots and make leaves yellow; for controls, see "Roots with dark tunnels" on page 61. See the Herbs entry beginning on page 116 for other possible problems.

Parsnip

Pastinaca sativa (Umbelliferae)

Parsnips are biennial vegetables grown for their long, white, sweet-flavored roots. Culture is much like that of carrots, except that

parsnips require less fertilizer and prefer a pH between 6.0 and 6.8. They grow best at temperatures between 60° and 64°F, poorly above 75°F, and tolerate temperatures as low as 40°F. Parsnip seed can take 3 weeks to germinate. Soak seed overnight before planting, keep seedbed moist, and always use fresh seed to prevent germination problems.

Parsnips are in the same family as carrots and are troubled by many of the same pests and diseases. See the Carrot entry beginning on page 60 for culture and information on problems.

Problems

Roots with dark cankers; leaves with water-soaked or dark spots. Cause: Brown fungal canker. Interior of root may be discolored, and other diseases can enter root through cankers and can rot flesh. Destroy severely infected plants and spray remaining plants with copper or bordeaux mix. Prevent problems by not planting parsnips where they have been grown for at least 2 years, providing good drainage, keeping soil over shoulders of roots, and planting resistant cultivars such as 'Andover' and 'Cobham Improved Marrow'.

Parthenocissus

Boston ivy, Virginia creeper, woodbine. Vines.

These are deciduous, alternate-leaved vines that climb by means of rootlike holdfasts.

Plant container-grown creepers in spring. A moist, loamy soil is best, in sun or shade. These plants are very adaptable to difficult conditions.

Japanese beetles can attack foliage; see "Leaves skeletonized" on page 236 for controls. For details on controlling scales, see "Leaves yellow; stems and leaves covered with small bumps" on page 237. Powdery mildew may disfigure leaves; see "Leaves with powdery white coating" on page 237 for controls. If leaf spots are a problem, see "Leaves with spots" on page 237.

Pea

Pisum sativum (Leguminosae)

Peas are annual vegetables grown for their tasty seeds and, in some cases, seedpods. Fresh peas are a special treat you have to grow yourself to enjoy.

Culture

Peas grow well in almost any soil, but do best in soil with lots of organic matter and a pH between 5.5 and 6.8. A 1" layer of compost worked well into the soil before planting will provide sufficient nutrients for a good crop.

Peas are a cool-season, moisture-loving crop. They grow best between 60° and 75°F, poorly at temperatures above 75°F, but will tolerate temperatures as low as 45°F. Pea foliage can withstand a light frost, but pods and flowers will be damaged unless they are covered.

Most disease problems in peas can be avoided with proper culture. Do not plant in wet soils. Plant in raised beds and add plenty of compost to loosen the soil. Rapid germination is essential to avoid root rot problems. Choose lighter soils for earliest plantings if you have a choice, and keep soil moist, but not wet. Avoid touching plants when they are wet. Dispose of vines after harvest and till soil to reduce future problems. Plant peas where no peas or beans have grown for at least 3 years.

Soak seed in compost tea for 15 minutes or as long as overnight to help prevent disease and speed germination. Treat seed with an

Copyrighted material

inoculant labeled for garden peas before planting to promote nitrogen fixation. Be sure to buy fresh inoculant each year, or check the date on the package for viability.

Peas are susceptible to certain micronutrient deficiencies. Spray young plants with seaweed extract every 2 weeks to help prevent deficiencies and boost production.

Leaf and Whole Plant Problems

Seeds do not germinate; seedlings stunted or dying. Causes: Seedcorn maggots; damping-off; root rot. Seedcorn maggots are 1/4" long, yellow-white, spindle-shaped seed-eaters. Adults are small flies. Seedlings that do come up are deformed and spindly. Remove damaged seedlings and plant fresh seed about a week after applying parasitic nematodes to the soil to control maggots. Seedcorn maggots thrive in cool, wet soil, so wait until soil is warm to plant to help avoid problems with them.

Damping-off is caused by soil-dwelling fungi that thrive in cool, wet conditions. Keep soil moist, but not soggy, thin seedlings to improve air circulation, and spray them with compost tea as soon as the first true leaves open to prevent problems.

Pea root rot can kill seedlings. Older infected plants are stunted and have shrunken, discolored roots and stems near the soil line. Prevent problems by planting in well-drained soil with lots of organic matter. Beans are susceptible to the same fungus, so keep the 2 crops apart. Prevent problems by planting cultivars, such as 'Bolero' and 'Sprite', that are somewhat tolerant to pea root rot.

Seedlings clipped off at soil line. Cause: Cutworms. Check for fat, 1"-2" long, dull brown or gray caterpillars in the soil near the base of plants. Sprinkle moist bran mixed with BTK on the soil surface in the evening, or apply parasitic nematodes to the soil at least a week before planting to control them.

Leaves yellow; growth slow. Causes: Nitrogen deficiency; waterlogged soil. Drench soil and spray foliage with compost tea, fish emulsion, or fish-meal tea, or side-dress plants with compost to alleviate deficiency symptoms. Waterlogged soil damages roots and prevents them from using nutrients available in the soil. Prevent problems by choosing well-drained sites, adding organic matter to the soil to improve drainage, and planting in raised beds.

Leaves yellow and distorted. Causes: Tarnished plant bugs; pea aphids; potato leafhoppers. Tarnished plant bugs are oval, light green or brown, 1/4" long bugs that inject a plant-deforming toxin as they feed on young leaves. Trap them with white sticky traps or treat plants with a commercial pyrethrin spray or dust in the evening to control severe infestations.

Pea aphids are soft-bodied, small, light to dark green, sucking insects usually found on new growth. Infested leaves are thickened and curled and may be covered with a sticky material. For light infestations, knock pests off plants with a blast of water. Spray plants with insecticidal soap in the evening to control, or with a commercial neem or pyrethrin spray if infestation is severe. Repel aphids with reflective mulch or by planting cultivars with silvery leaves.

Potato leafhoppers are green or brown, spindle-shaped, 1/10"-1/2" long, winged insects. Nymphs are smaller and wingless. Infested leaves have curled margins, and flowers or pods may fall off. Trap leafhoppers with yellow sticky traps or spray as for pea aphids above. Cover seedlings with row cover if leafhoppers have been a problem in the past.

Leaves yellow; plant wilting and stunted. Cause: Fusarium wilt. Stem near soil line is yellow-orange to black when cut open. If pods form, they contain few seeds. Destroy plants infected with this fungal disease. To prevent problems, plant resistant cultivars such as 'Bounty', 'Daybreak', 'Green Arrow', 'Knight',

'Maestro', 'Oregon Sugar Pod 2', 'Snowflake', and 'Sparkle'.

Leaves mottled and distorted. Cause: Mosaic viruses. Destroy infected plants. Control aphids and cucumber beetles that spread viruses, and leguminous weeds, such as vetch, that can harbor viruses. Prevent problems by planting tolerant cultivars such as 'Knight' and 'Maestro'.

Leaves stippled with white. Cause: Mites. Leaves become bronzed when severely infested. These tiny, spiderlike insects thrive in hot, dry weather. Look for tiny moving specks on the undersides of leaves. Spray plants with insecticidal soap in the evening to control mites.

Leaves with water-soaked or white spots. Causes: Downy mildew; powdery mildew. Downy mildew is common in damp weather. Leaves and pods are covered with a thick, white growth that turns violet-black. Powdery mildew is more common in dry weather. The whole plant may be covered with white powdery growth. Spray plants with sulfur in the evening, as soon as you notice either disease. Prevent problems by planting cultivars resistant to downy mildew, such as 'Green Arrow' and 'Knight', or to powdery mildew, such as 'Bounty', 'Knight', 'Maestro', 'Oregon Sugar Pod 2', and 'Snowflake'.

Leaves with light brown to purple spots. Cause: Blight. Stems and pods are also spotted. Leaves may turn yellow and plants may die. Various fungi and bacteria can cause these disease symptoms. Spray plants with copper if weather is wet. Remove severely infected plants. Presoak seed in compost tea and don't touch plants when they are wet to help prevent problems.

Leaves with wandering, white or translucent tunnels. Cause: Leafminers. Larvae are white maggots that tunnel through leaves. Adults are tiny black-and-yellow insects. Once tunnels appear, the larvae are inside leaves and spraying will not kill them. Destroy infested leaves. Trap future generations of adults with yellow sticky traps, and treat plants with a commercial neem or pyrethrin spray if large numbers of adults are trapped. Prevent problems by protecting plants with row cover as soon as they come up to exclude egg-laying adults. Certain parasitic nematodes can attack leafminer larvae inside leaf tunnels.

Leaves with small holes. Cause: Cucumber beetles. Damage usually occurs on young plants. Beetles are yellow or greenish, ¼" long, with spots or stripes. Treat plants with a commercial pyrethrin spray or dust if infestation is severe. Cover emerging seedlings with row cover to prevent problems.

Leaves with large holes. Cause: Caterpillars. Many caterpillars feed on leaves and pods. Handpick, or spray plants with BTK if worms are feeding.

Pod Problems

Blossoms drop; no pods form. Causes: Weather extremes; nutrient imbalances. Excessive heat or rain can cause blossoms to drop. Wait for new blossoms to form. Copper and/or molybdenum deficiency cause the same symptoms. Spray plants with seaweed extract to help prevent deficiencies. If plants are very dark green and no blossoms form, suspect too much nitrogen. Wait for blossoms to form. Avoid high-nitrogen fertilizers.

Young pods distorted and withered; older pods with water-soaked or purplish spots. Cause: Blight. See "Leaves with light brown to purple spots " above for controls.

Pods mottled, deformed, and rough. Cause: Mosaic viruses. See "Leaves mottled and distorted" above for controls.

Pods with white spots. Causes: Downy mildew; powdery mildew. See "Leaves with water-soaked or white spots" above for controls.

Pods with chewed holes. Cause: Caterpillars. Various caterpillars eat pea pods. Handpick, or spray plants with BTK if cater-

pillars are feeding. Cover young plants with row cover to prevent moths from laying eggs.

Seeds with brown spots or cavities. Cause: Manganese deficiency. Spray plants with seaweed extract every 2 weeks to prevent deficiencies.

Seeds with small, round holes. Cause: Pea weevils. Seeds may be hollow. Fat, white, ⅓" long larvae feed on seeds. Adults are ⅓" long, dark beetles with light markings that may feed on pea flowers. Discard infested seeds; do not compost them. Cover seeded areas with row cover to prevent adults from laying eggs. Spray plants with pyrethrin if adults are present.

Peach

Prunus persica (Rosaceae)

Peaches are deciduous trees growing from 4′ to 20′, depending on soil, rootstock, and cultivar. In very early spring pink blossoms appear on last year's shoots. Nectarines belong to the same species as peaches and have the same cultural requirements as well as the same diseases and pests. Both are hardy in Zones 5-9.

Culture

Plant in full sunlight in an area with well-drained soil and no late spring frosts. Prune each winter to stimulate growth, to thin next year's fruit, and to allow sunlight to penetrate the tree. Train trees to a framework of well-spaced, wide-angled branches. Prune bearing trees each winter to admit light into the tree and encourage good air circulation. As you prune, remove diseased and spindly wood and crossed branches. Where growth is too dense, remove extra shoots at their bases. To develop growth on spindly shoots, prune off the end of the shoot just above an outward-facing bud. For more pruning information, see "Pruning and Training" on page 101. Thin fruit each spring so it has room to develop.

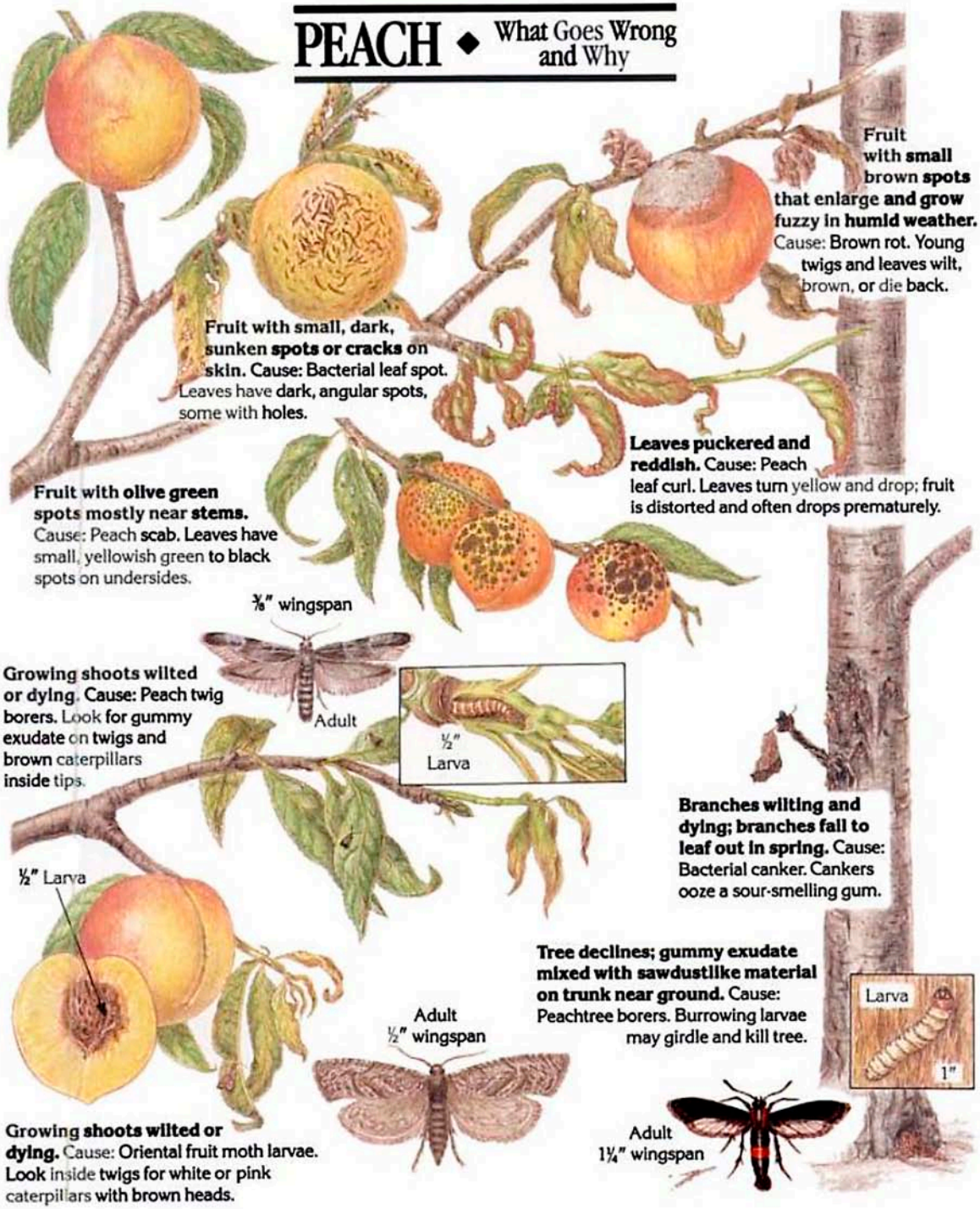
Like other fruit trees, peach trees need a period of cold weather rest or dormancy. The number of hours of cold between 32° and 45°F each cultivar needs before it breaks dormancy is referred to as chill hours. (Cold below 32°F doesn't count toward meeting the dormancy requirement.) Once the number is reached, the tree assumes winter is over and starts growing the next warm day. Peaches bloom rapidly once their requirement has been met, which makes them more prone to frost damage than other fruit trees that are slower to burst into bloom. Call your local extension service to find out how many chill hours your area receives and what cultivars match that requirement. If you choose a cultivar that needs fewer chill hours than you normally receive, an unseasonable winter thaw in your area may bring the tree well into flower weeks before spring actually arrives. But if you choose one that needs more chill hours than your climate supplies, the tree won't get enough chilling to stimulate normal bloom.

Most peaches are self-pollinating, but a few cultivars, such as 'Indian Free' and 'J. H. Hale', require cross-pollination. For more information on setting fruit, see "Setting Fruit" on page 101.

Fruit Problems

Young fruit with crescent-shaped scars. Cause: Plum curculios. These beetles, common east of the Rockies, leave characteristic scars as they lay eggs in fruit. Damaged fruit often drops. For control, spread a dropcloth under the tree and jar the trunk and branches with a padded mallet. Collect and destroy beetles that fall onto the sheet. For best results,

PEACH ◆ What Goes Wrong and Why


Fruit with small brown spots that enlarge and grow fuzzy in humid weather. Cause: Brown rot. Young twigs and leaves wilt, brown, or die back.
Fruit with small, dark, sunken spots or cracks on skin. Cause: Bacterial leaf spot. Leaves have dark, angular spots, some with holes.
Leaves puckered and reddish. Cause: Peach leaf curl. Leaves turn yellow and drop; fruit is distorted and often drops prematurely.
Fruit with olive green spots mostly near stems. Cause: Peach scab. Leaves have small, yellowish green to black spots on undersides.
⅜" wingspan
Adult
Growing shoots wilted or dying. Cause: Peach twig borers. Look for gummy exudate on twigs and brown caterpillars inside tips.
½" Larva
Larva
Branches wilting and dying; branches fail to leaf out in spring. Cause: Bacterial canker. Cankers ooze a sour-smelling gum.
½" Larva
Tree declines; gummy exudate mixed with sawdustlike material on trunk near ground. Cause: Peachtree borers. Burrowing larvae may girdle and kill tree.
Larva
1"
Adult
½" wingspan
Adult
1¼" wingspan
Growing shoots wilted or dying. Cause: Oriental fruit moth larvae. Look inside twigs for white or pink caterpillars with brown heads.

do this twice a day, beginning when you see the first scarred fruit. Also, to prevent curculio eggs from hatching, collect and discard dropped fruit. For more information, see "Young fruit with crescent-shaped scars" on page 186.

Fruit with small brown spots that enlarge and grow fuzzy in humid weather. Cause: Brown rot. This fungus may also cause blossoms to wither and die. Fruit is most infection-prone 3 weeks before ripening. Infected fruit may drop early or turn soft and brown, then wither into hard, black, shriveled fruit (known as mummies) that remains on the tree. For control, inspect trees before growth begins in the spring. Remove and destroy both mummies and twigs or branches with gummy lesions. For more control, spray sulfur early to protect blooms, then again later to protect fruit. Copper sprays also help. Since damaged fruit is more prone to infection, control insects such as plum curculios, which puncture fruit and allow infection to enter. Resistant cultivars include 'Elberta', 'Orange Cling', 'Red Bird', and 'Sunbeam'. See page 165 for an illustration of this disease.

Fruit with olive green spots mostly near stems. Cause: Peach scab. Spots first appear on immature fruit and then turn brown and velvety. Fruit skin cracks; fruit is distorted or dwarfed. Infection arises from twig lesions, but damp weather spreads the fungus throughout leaves, fruit, and twigs. Infection is worst in warm climates and in late-fruiting cultivars. See page 165 for an illustration of this disease. To control scab, remove infected fruit and clean up fallen leaves and fruit. For persistent infection, spray lime-sulfur or sulfur only every 10-21 days throughout the growing season. If spring weather is unusually warm and wet, spray sulfur weekly from the time flower buds first show green until blossoms begin to open.

Fruit with small, dark, sunken spots or cracks on skin. Cause: Bacterial leaf spot. This disease, common east of the Rockies, spreads in the spring from oozing cankers. Twig cankers appear water-soaked. Leaves turn yellow and drop. Infection weakens trees, makes them prone to winter injury, and reduces fruit quality and yields. See page 165 for an illustration of this disease. Control with copper spray. Resistant cultivars include 'Belle of Georgia', 'Candor', 'Com-Pact Red Haven', 'Dixieland', 'Earlired', 'Early-Red-Free', 'Harbrite', 'Harken', 'Loring', 'Madison', and 'Red Haven'.

Fruit with sunken, corky lesions. Cause: Tarnished plant bugs. Bugs hibernate in nearby weeds and move into trees in the spring. For control, remove weeds and plant debris. For persistent infestation, hang white sticky traps in lower tree branches.

Fruit with pinkish worms. Cause: Oriental fruit moth larvae. For more information, see "Growing shoots wilted or dying" below.

Leaf and Branch Problems

Growing shoots wilted or dying. Causes: Oriental fruit moth larvae; peach twig borers. Both pests tunnel into growing shoots and cause wilting. With oriental fruit moths, the tree may look unusually bushy from growth of new lateral shoots below wilted parts. To find oriental fruit moth larvae, slit stems below the wilted sections and look for a pinkish white caterpillar, up to ½" long. Later, a second larval generation bores into and ruins fruit. Controls that help keep this pest in check include repeated, timely sprays of BTK and release of the parasitic wasp *Macrocentrus ancylivorus*. Use pheromone traps to monitor and control the pests. Mating disruption pheromones, such as Isomate-M, are also effective. See page 165 for an illustration of an oriental fruit moth larva.

Wilting plus a gummy exudate from twigs may indicate peach twig borers. This pest also damages fruit. The second generation of these brown, ½" caterpillars tunnels into fruit, usu-

ally near the stem. For control, find borer entry holes and cut off wilted branches just below the hole. Destroy infested prunings. For large branches, slide a wire into the hole to kill the borer. Peach twig borers prefer weak trees; keep trees strong through proper fertilization, pruning, and irrigation. See page 165 for an illustration of this pest.

Growing shoots covered with a white powdery coating. Cause: Powdery mildew. This disease also causes new growth to be stunted and distorted. Rainy weather does not cause the disease fungus to spread. In fact, it is most common in weather patterns featuring cool nights changing to warm days. For control, apply sulfur spray or lime-sulfur spray.

Young twigs and leaves wilted, brown, or dying back. Cause: Brown rot. Shoots and leaves may turn brown and decay. Gummy branch or twig lesions may also form. For more information, see "Fruit with small brown spots that enlarge and grow fuzzy in humid weather" above.

Leaves puckered and reddish. Cause: Peach leaf curl. Later in the season, infected leaves may yellow, shrivel, and drop. New growth is stunted and swollen and often dies. Fruit often drops prematurely and may have a reddish, irregular, rough surface. See page 165 for an illustration of this disease. You can't cure this fungal disease during the current season, but copper sprays or lime-sulfur sprays help control it. Resistant cultivars include 'Candor', 'Clayton', 'Com-Pact Red Haven', 'Correll', 'Dixieland', 'Elberta', 'Red Haven', and 'Stark EarliGlo'.

Leaves with dark, angular spots; some spots with holes. Cause: Bacterial leaf spot. Eventually, infected leaves may yellow and drop. For more information, see "Fruit with small, dark, sunken spots or cracks on skin" above.

Leaves with small purple spots, some spots with centers missing. Cause: Shothole disease. Spots also appear on fruit and then turn scabby. Centers of leaf spots often enlarge to about ¼", then fall out. You can't cure this fungus during the current season, but copper spray aids control. Keeping irrigation water away from foliage also helps. Dormant season pruning of infected buds and twigs, which have a varnished appearance, helps prevent the disease next year.

Leaves stippled yellow. Cause: European red mites. These extremely tiny spider mites suck juices from leaves, causing yellow speckles on foliage. For light infestations, knock mites off leaves with a strong spray of water; for heavy infestations, spray with insecticidal soap. Lime-sulfur spray applied early in the growing season also aids control. Or, to kill overwintering mite eggs, apply superior oil in the spring, just when leaf buds are about ½" long. Mites are controlled by natural enemies, including predatory mites. If simple controls don't work, purchase predatory mites (*Metaseiulus occidentalis*) from insectaries or organic farm and garden supply catalogs.

Branches wilting and dying, fail to leaf out in spring. Causes: Bacterial canker; Valsa canker. Look on the branches for sunken, elliptical lesions, often oozing a reddish gum. With bacterial canker, this gum smells sour, and leaves may have small, angular spots. See page 165 for an illustration of this disease. For both cankers, prune wilted or dying branches off below the infected area. Sterilize pruning tools in isopropyl alcohol or a 10 percent bleach solution (1 part bleach to 9 parts water) between cuts. On large limbs, cut out the canker into healthy wood, which has a lighter color. Copper sprays help control bacterial canker.

Valsa canker is a fungal disease that enters through injured bark. To prevent bark damage, make sure trees harden off in the fall by avoiding late-season fertilization or pruning. Also plant in well-drained soil and paint trunks with white latex paint diluted with an equal amount of water to reduce bark-damaging

temperature fluctuations. Train trees to a good form with strong, wide-angled scaffold limbs. Also prune during bloom time, when wounds heal fastest. Cultivars adapted to cold climates or that drop leaves early are most resistant to Valsa canker. Choose 'Brighton', 'Elberta', 'Harbrite', 'Harken', 'Madison', or 'Reliance'.

Whole Plant Problems

Leaves yellow; dieback of whole limbs. Cause: Scales. Colonies of these sucking insects cling to the bark and appear as small bumps that can be easily scraped off with a fingernail. Control scale by spraying trees with dormant oil in the winter. Also control ants, which encourage scale insects, by wrapping a strip of paper or plastic around the trunk and covering it with a commercial sticky coating such as Tanglefoot.

Tree declines; gummy exudate mixed with sawdustlike material on trunk near ground. Cause: Peachtree borers. Inspect the trunk near or just below the ground; you may find holes and a gummy exudate made by peachtree borers, which are the larvae of a clear-winged moth that bore the inner bark. See page 165 for an illustration of this pest. Dig borers out, being careful to minimize tree damage, or kill them by inserting a wire into holes. Cultivating shallowly around the base of the tree discourages these pests. Peachtree borers are attracted to weak trees. Keep trees vigorous and avoid mechanical damage. Resistant cultivars include 'Dixie Red', 'Elberta', and 'Jubilee'.

Leaves unusually small; leaves yellow or oddly shaped. Cause: Viral infection. A few viral diseases cause leaf anomalies in peach trees. One particular virus, known as peach rosette, causes trees to produce shoots that have abnormally short distances between the leaf nodes. Avoid viruses by starting with clean stock. Avoid planting near possible virus carriers, such as old peach trees or wild chokecherries (*Prunus virginiana*). Remove and destroy infected trees.

Pear

Pyrus communis and hybrids (Rosaceae)

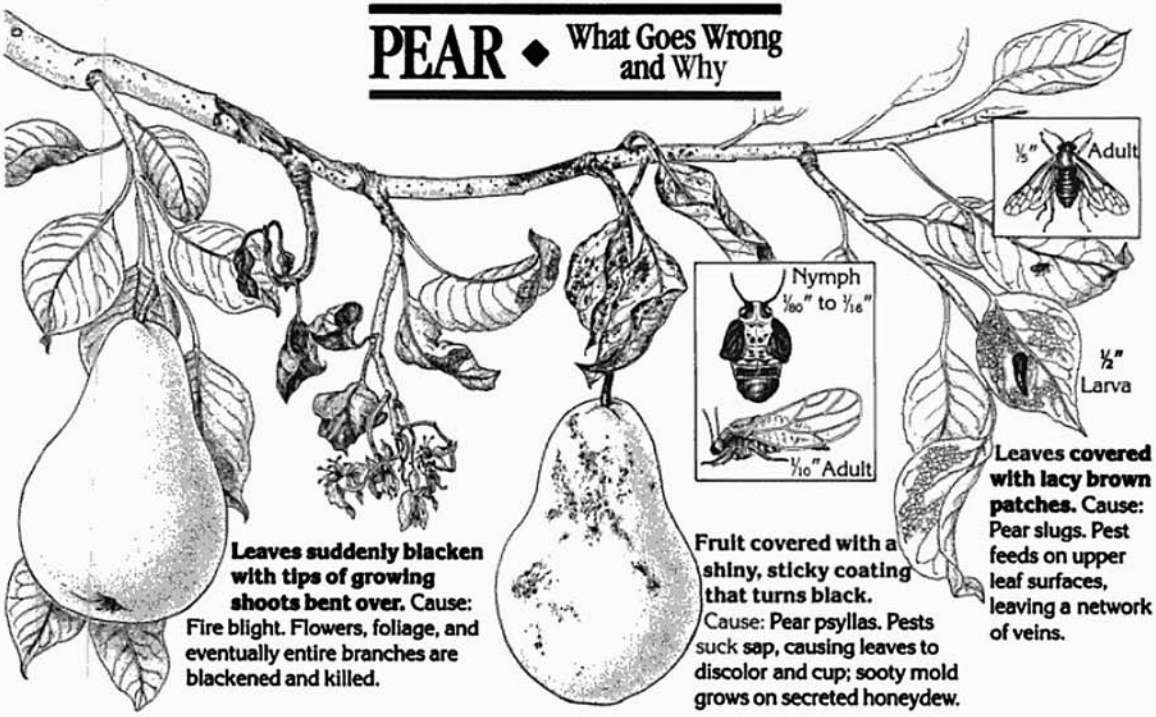
Pears are deciduous, upright-growing trees ranging in size from about 8′ to more than 30′, depending on the cultivar and rootstock. The white blossoms appear in spring mostly on spurs—short growths that elongate less than an inch each year. Fruit ripens from late summer into autumn. Most gardeners are familiar with European pears, including the familiar 'Bartlett' and 'Bosc' pears. However, Asian pears, which have crisp, juicy, almost-round fruit, will also grow well in most parts of the United States and Canada. Pears are hardy in Zones 4-9.

Culture

Pears require full sun. They enjoy well-drained, moderately fertile soil, but will tolerate heavy or poorly drained soils more easily than most other fruits. Since pears flower later than most other common fruits, they do not require a site completely free of spring frost. Train European pears to a central leader system and Asian pears to an open-center system. See the illustration on the opposite page. Prune bearing trees a moderate amount, enough to allow light into the tree and to stimulate enough new growth to replace old spurs or branches that have been removed. For more pruning information, see "Pruning and Training" on page 101. To set fruit, most pear cultivars require cross-pollination from a second compatible cultivar planted nearby. Before buying any cultivar, be sure you can meet the pollination requirements. For more information, see "Setting Fruit" on page 101.

Fruit Problems

Fruit with olive-brown, corky spots that turn dark brown. Cause: Pear scab. This fun-


PEAR ◆ What Goes Wrong and Why
Adult
Nymph
1/80" to 1/16"
1/10" Adult
1/2" Larva
Leaves suddenly blacken with tips of growing shoots bent over. Cause: Fire blight. Flowers, foliage, and eventually entire branches are blackened and killed.
Fruit covered with a shiny, sticky coating that turns black. Cause: Pear psyllas. Pests suck sap, causing leaves to discolor and cup; sooty mold grows on secreted honeydew.
Leaves covered with lacy brown patches. Cause: Pear slugs. Pest feeds on upper leaf surfaces, leaving a network of veins.

gal disease may also cause malformed fruit. It overwinters on fallen leaf litter and infected twigs and spreads to the tree in the spring when warm air currents and splashing rain move fungal spores from the ground into the tree. To control pear scab, remove old leaves from beneath trees and compost or bury them. Prune out infected twigs, which bear small, blisterlike pustules. Do both of these chores in late winter or early spring before growth begins. Lime-sulfur applied early in the growing season also helps control the disease. Scabby fruit may be unattractive, but it is still edible once diseased portions are cut away. If scab is prevalent in your area, plant scab-resistant cultivars, such as 'Bartlett'.

Fruit with holes surrounded by brown, crumbly excrement. Cause: Codling moth larvae. These fat, white or pinkish, 7/8" caterpillars tunnel through fruit and may have departed by the time you discover the holes, which may be filled with what looks like moist sawdust. Infested fruit may drop prematurely. For light infestations, kill eggs by spraying superior oil on leaves and twigs within 2-6 weeks of blossoming. For heavy infestations, kill larvae before they tunnel into fruit by spraying the tree canopy with pyrethrin at petal fall and again 10-14 days later. Mixing the pyrethrin with a synergist (see "The Other Ingredients" on page 469) can improve control. For more information, see "Fruit with holes surrounded by brown, crumbly excrement" on page 22.

Fruit covered with a shiny, sticky coating that turns black. Cause: Pear psyllas. These 1/10", red to green, winged insects resemble cicadas. They overwinter in tree crevices and ground litter and emerge in early spring to lay eggs in trees. Newly hatched psylla nymphs

pierce and suck juices from both foliage and fruit. Most regions support at least 4 generations of this pest per year, allowing plenty of opportunity for infestation throughout the growing season.

The sticky coating on fruit is honeydew excreted by the psyllas, and the black blotches are mold that grows on the honeydew. Frequently, yellow jackets congregate around honeydew-coated leaves. You can clean the honeydew or mold off the fruit and eat it. Excessive psylla feeding will weaken the tree. To control psyllas, smother overwintering adults with dormant oil sprays applied in late winter before spring growth begins. During the growing season, kill eggs and mature young with superior oil spray or insecticidal soap.

Leaf Problems

Leaves suddenly blacken, with tips of growing shoots bent over. Cause: Fire blight. Don't confuse this bacterial disease with sooty mold, a black fungus that rubs off easily. Fire blight bacteria enter the tree at the growing tips and may travel down toward the roots and kill the whole tree.

Fire blight most readily attacks very succulent growth; to make trees a little more blight-resistant, avoid heavy pruning or nitrogen fertilizer, both of which induce vigorous growth. When pruning, thin out whole branches rather than heading them back. This pruning strategy reduces the total number of cuts and won't stimulate the growth of soft, blight-susceptible, sideshoots. To prevent rampant growth on mature trees, grow grass right up to the trunk; if needed, allow the grass to grow longer than normal.

Control fire blight during the growing season by pruning off branches a foot below infected sections. Between each cut, dip pruning shears into isopropyl alcohol or a 10 percent bleach solution (1 part bleach to 9 parts water) to prevent spreading the disease as you prune. As the growing season progresses, fire blight bacteria grow within blighted shoots down branches and toward the roots. During the fall, the bacteria form a sunken, dark canker in which to overwinter. Over the winter, inspect branches for these cankers and prune off damaged branches at least 6″ below the cankers.

One way to prevent fire blight from killing an entire tree is to purchase trees in which a blight-susceptible cultivar has been grafted onto blight-resistant framework. Good rootstocks include the 'Old Home' × 'Farmingdale' series, *Pyrus betulifolia,* and *P. calleryana.* Copper sprays applied in spring may also reduce the incidence of fire blight, but spraying alone will not control the disease. Cultivars fairly resistant to fire blight include 'Duchess', 'Garber', 'Moonglow', 'Orient', 'Seckel', 'Seuri', 'Shinko', 'Starking Delicious', and 'Yali'.

Leaves suddenly blacken in autumn. Cause: Pseudomonas blight. You might mistake this disease for fire blight, but fire blight symptoms appear in warm spring weather, and its cankers ooze in the spring. Pseudomonas blight first appears during cool fall weather and its cankers do not ooze in the spring. Control it by pruning, as for fire blight (see "Leaves suddenly blacken, with tips of growing shoots bent over" above).

Leaves with small, round, dark spots having purple margins. Cause: Fabraea leaf spot. This disease, most common east of the Mississippi River, may cause leaves to turn yellow and drop, weakening the tree. Since the disease overwinters in twig cankers as well as fallen leaves, garden sanitation does little to control the disease. Copper spray, applied when leaves are half out and then once or twice again at 2-week intervals, offers some control.

Leaves with dark, velvety patches. Cause: Pear scab. The spots are mostly on leaf undersides, and infected leaves often pucker and drop. For more information, see "Fruit with olive-brown, corky spots that turn dark brown" on page 168.

Leaves covered with lacy brown patches. Cause: Pear slugs. These green-black, slimy creatures are not true slugs; they're the larvae of the pear sawfly, a black-and-yellow insect slightly larger than a housefly. In the spring, sawflies emerge from soilborne cocoons and lay eggs on leaves. Eggs hatch into sluglike larvae that skeletonize leaves. Remove them by handpicking or with blasts of water. For heavy infestations, use insecticidal soap spray; on a dwarf tree, apply wood ashes or diatomaceous earth. (Caution: Wood ashes may damage leaf tissue.) Spider mites multiply quickly in dry, dusty conditions, so wash ashes off after a few days to avoid encouraging a rise in spider mite population.

Leaves with small brown blisters on undersides. Cause: Pearleaf blister mites. Inside these blisters are small, elongated, white mites that you need a magnifying glass to see. Damage usually is cosmetic and can be ignored, but if control is necessary, spray lime-sulfur before buds open or superior oil as buds swell. Be sure to spray oil thoroughly to kill adults hiding in bud scales.

Leaves turn yellow; limbs die back. Cause: San Jose scale. If limb dieback is preceded by extensive leaf yellowing, look for the small gray bumps of San Jose scale clinging to the bark. Colonies of these sucking, nearly immobile insects cling to bark and weaken trees by sucking sap. Control scale with dormant oil spray applied in late winter.

Pecan

Carya illinoinensis (Juglandaceae)

Pecans are large, deciduous trees with separate male and female flowers borne on the same plant. These plants are hardy in Zones 6-9. Trees grown at the northern hardiness limit may not have a long enough season to ripen nuts.

Plant pecans in deep, well-drained soil in full sun. Trees need almost no pruning. Since male and female flowers on a given tree often mature at different times, plant 2 different cultivars to ensure pollination.

Problems

Nuts contain insect larvae. Causes: Pecan weevil grubs; hickory shuckworms; pecan nut casebearer larvae. Pecan weevils, snouted beetles similar to plum curculios, lay eggs within newly formed nut kernels; larvae that hatch from these eggs feed on the nut and emerge several weeks later through tiny holes in the shell and husk. Infested nuts are worthless and generally cling to the tree instead of splitting normally from the hulls. To control this pest, place dropcloths beneath the tree and jar the limbs with padded poles. Collect and destroy the fallen adults. Do this every 2 weeks beginning in midsummer until weevils no longer drop.

You will find cream-colored, 3/8" hickory shuckworms eating the kernels of immature nuts that drop early as a result of the infestation. These pests are the larvae of gray moths, and the final larval generation overwinters on the ground in dropped shucks. To control shuckworms, keep dropped hulls picked up or bury them at the end of the season.

Pecan nut casebearers, 1/2", green larvae of a gray moth, spin webs around nuts and then enter to feed. Infested nuts may drop prematurely. Overwintering larvae leave cocoons in early spring and bore into growing shoots, causing wilting. Damage is worst early in the season. To help control casebearers, pick up and destroy all dropped infested nuts. The parasitic wasp *Trichogramma minutum* attacks and parasitizes casebearer eggs. For heavy infestations of casebearers, release 5,000 of these wasps per infested tree.

Leaves with olive-brown spots on undersides; shucks with small, velvety, olive-brown spots. Cause: Pecan scab. Leaf spots may enlarge to large black areas. The spots on the shucks may spread into large, sunken, black lesions. Nuts may drop prematurely. This fungal disease is worst in humid areas and overwinters on infected twigs, shucks, and leaves. To reduce infection the following season, clean up plant debris in autumn and knock off old leaf stems and shucks before trees leaf out in the spring. Scab-resistant cultivars include 'Cape Fear', 'Chocktaw', 'Curtis', 'Desirable', 'Gloria Grande', and 'Stuart'.

Tree declines; leaves yellow, die, but remain on tree. Cause: Cotton root rot. Roots of infected trees are brownish, rotted, and soft. Cotton root rot fungus lives in the soil for 5 years or more, thriving especially in areas with heavy, moist, alkaline soil. An acid-type fertilizer might help mildly affected trees, but dig up dying trees and do not replant with pecans.

Pelargonium

Pelargonium, geranium.
Tender perennials grown as annuals.

Pelargoniums, commonly known as geraniums, are easy-to-grow plants that are popular with both beginner and advanced gardeners. Most gardeners grow flowering geraniums for the clusters of red, pink, lilac, salmon, or white flowers that appear all season over 1′-3′ plants. Other geraniums are grown primarily for their fragrant leaves, which release powerful scents when brushed. Geraniums can also have attractively shaped and variegated foliage, with up to 4 colors in just 1 leaf. In mild climates geraniums persist throughout the year. They are delightful in beds, borders, pots, and hanging baskets.

Buy new nursery-grown plants each year, or start your own from seed. You can direct-seed outdoors in late spring, although indoor seeding in late winter or early spring gets better results. Good window or artificial light is needed indoors. Cover seeds lightly. Germination is erratic within 3-8 weeks. When seedlings have 2-3 true leaves, transplant them to individual 3″ pots. After the last frost, plant outdoors 10″ apart.

Geraniums usually need full sun. In the Deep South, give them light shade, or plants may burn. Soil should be well-drained, medium rich, and slightly acid; if it is alkaline, add peat moss to planting area. Water regularly, letting the soil dry out slightly between waterings. Fertilize regularly but lightly; overfeeding results in large leaves and fewer flowers. Remove spent flower heads to prolong blooming. Pinching back growing tips in early stages promotes fullness. Cut the plant back if it becomes leggy.

Problems

Leaves yellow; plant weakened. Cause: Whiteflies. For controls, see "Leaves yellow; plant weakened" on page 18.

Leaves stippled with yellow; foliage webbed. Cause: Spider mites. For control measures, see "Leaves stippled with yellow; foliage webbed" on page 18.

Leaves, stems, and buds distorted. Cause: Aphids. See "Leaves, stems, and buds distorted" on page 20 for controls.

Stems with rotted sections; leaves wilt. Cause: Stem rot. This fungal disease starts at the base of plants and works upward. It commonly affects cuttings, but can also injure full-grown plants. Stems often turn black. Only take cuttings from healthy plants, and stick

them in a sterile medium. Remove and destroy affected parts or plants.

Leaves with spots. Cause: Leaf spots. See "Leaves with spots" on page 19 for control information.

Leaves with large, ragged holes. Cause: Slugs and snails. See "Leaves with large, ragged holes" on page 18 for controls.

Pepper

Capsicum annuum var. *annuum* (Solanaceae)

Peppers are tender perennials that are grown as annuals in temperate climates for their sweet to fiery hot fruit. Pick peppers when they are unripe and green (or sometimes yellow or purple-black) or after they ripen to red, orange, yellow, or brown, depending on the cultivar. In general, ripe peppers are sweeter or less hot than unripe ones of the same cultivar.

Culture

Peppers require deeply worked, well-drained soil with lots of organic matter. They do best at a pH between 6.0 and 6.8, but tolerate pH as low as 5.5. Peppers require a moderate to high level of nitrogen and moderate levels of phosphorus, potassium, and calcium. Have the soil tested and amend as needed before planting. Peppers grow best between 65° and 80°F. Temperatures above 85° or below 60°F can cause blossoms to drop without setting fruit.

Peppers tolerate drought, but do best in soil that is evenly moist, but not soggy. Plant in raised beds to improve drainage, if needed. Stake peppers to keep fruit from touching the ground and use mulch to control weeds and prevent soilborne diseases from splashing up on the fruit.

Do not plant peppers where tomatoes, potatoes, eggplants, or peppers have been planted within the past 3-5 years. Also, try to plan your planting scheme to separate these crops in the garden. Compost or till under all plant residues at the end of the season, and till the soil to reduce overwintering pests.

Purchase sturdy, insect- and disease-free plants, or start your own from seed indoors. Soak seed in a 10 percent bleach solution (1 part bleach to 9 parts water) for 10 minutes, and rinse in clean water before planting to reduce seed-borne diseases. Pepper seeds germinate best above 80°F. Once seedlings are up, they grow best at 70°F during the day and 60°F during the night. Wait until soil temperatures reach 65°F before setting out transplants. Spray transplants with an antitranspirant to help reduce disease problems, and water them with seaweed extract or compost tea to give them a good start. To improve fruit set, spray plants with seaweed extract with 1 teaspoon of Epsom salts added to 1 gallon when the first flowers open.

Leaf and Whole Plant Problems

Seedlings fall over; stems girdled or rotted at soil line. Cause: Damping-off. Disinfect reused pots and flats by dipping them in a 10 percent bleach solution and letting them air-dry before filling them with fresh seed-starting mix. Sow seeds thinly to allow for air movement around seedlings. Cover seed with a thin layer of soilless mix or vermiculite. Water only enough to keep soil moist, not soggy. Thin seedlings and spray with compost tea as soon as first true leaves open to help prevent the problem.

Seedlings clipped off at soil line. Cause: Cutworms. Check for fat, 1"-2" long, dull brown or gray caterpillars in the soil near the base of plants. Once they chew off a seedling, there is

nothing you can do except protect the remaining seedlings from nocturnal cutworm attacks. Place cutworm collars around transplants, sprinkle moist bran mixed with BTK on the soil surface in the evening, or add parasitic nematodes to the soil at least a week before planting to control them.

Leaves pale green and small. Cause: Nitrogen deficiency. Spray plants and drench roots with fish emulsion to alleviate symptoms, and side-dress with compost.

Leaves yellow, distorted, and sticky. Cause: Aphids. These small green, pink, black, gray, or white fluffy-coated insects suck plant sap. For mild infestations, knock pests off plants with a blast of water. Spray plants with insecticidal soap in the evening to control, or with a commercial neem or pyrethrin spray if infestation is severe.

Leaves mottled with yellow; young growth malformed. Causes: Tobacco mosaic virus; other viral diseases. Destroy diseased plants. Presoak seed in a 10 percent bleach solution before planting, or choose resistant cultivars to prevent problems. Wash hands after handling tobacco and before touching peppers to prevent tobacco mosaic virus (TMV). Control aphids, because they spread viral diseases as they feed. Prevent problems by planting resistant cultivars such as 'Ace', 'Bell Captain', 'Bell Tower', 'Early Wonder', 'Elisa', 'Galaxy', 'Goldcrest', 'Gypsy', 'Lady Bell', 'Lasto', 'Northstar', 'Orobelle', and 'Yolo Wonder'.

Leaves yellow; plant stunted and wilts in hot weather. Cause: Nematodes. Plants eventually die. Roots may have swollen galls. Destroy infested plants, do not compost them. To control these pests, apply chitin or parasitic nematodes to the soil.

Older leaves yellow; shoots or whole plant wilts. Cause: Fusarium or Verticillium wilt. Fusarium wilt and Verticillium wilt are both fungal diseases and are difficult to tell apart. Both Fusarium and Verticillium wilt begin as a yellowing and wilting of the lower leaves. Plants are stunted and do not recover when watered. Cut open a stem near the soil line and look for internal discoloration. Verticillium fungi are active between 68° and 75°F, while Fusarium is active between 80° and 90°F. Destroy infected plants. Pepper Fusarium infects only peppers, while Verticillium infects a wide range of plant species, making effective rotation control difficult. Prevent problems by presoaking seed in a 10 percent bleach solution. Control pest nematodes to help reduce wilt problems. Few wilt-resistant cultivars are available; 'Giant Szegedi' is tolerant of Verticillium.

Leaves stippled yellow, or bronzed. Cause: Mites. Leaves turn dry and papery. These tiny, spiderlike insects thrive in hot, dry weather. Spray plants with insecticidal soap if populations are high (more than 1-2 pests per leaf).

Leaves with small, sunken, yellow-green spots. Cause: Bacterial spot. Spots eventually turn brown with lighter centers. Spray plants with copper as soon as symptoms appear to prevent further symptom development. Presoak seed in a 10 percent bleach solution to disinfect, and avoid touching wet plants.

Leaves with gray-brown spots. Cause: Cercospora leaf spot. This fungal disease only occurs in very warm climates. Spots develop a "frog-eye" appearance with light centers and dark edges. Spray plants with copper as soon as symptoms appear to prevent further symptom development. Presoak seed in a 10 percent bleach solution and plant resistant cultivars, such as 'California Wonder', to prevent problems.

Leaves with wandering, white or translucent tunnels. Cause: Leafminers. White, maggotlike larvae feed inside leaves, leaving empty tunnels behind them. Once larvae have entered leaves, spraying will not control them. Destroy mined leaves. Cover plants with row cover until flowers open to prevent adults from laying eggs on plants. Certain nematodes can attack leafminer larvae inside leaf tunnels.

Leaves with small holes. Cause: Flea beetles. Young transplants are the most susceptible. These tiny, black, brown, or bronze insects hop when disturbed. Spray or dust plants with pyrethrin if infestation is severe. Protect transplants with row cover until they start to flower.

Leaves with large holes. Causes: Hornworms; other caterpillars. Hornworms are 3"-4½" caterpillars with white diagonal stripes. The tobacco hornworm has a red horn projecting from the rear, while the tomato hornworm has a black horn. Handpick or spray plants with BTK to control them. Do not spray caterpillars that are covered with small white cocoons; these cases contain the larvae of parasitic wasps that are natural hornworm predators.

Other caterpillars such as European corn borers and corn earworms sometimes feed on pepper leaves and fruit. Handpick, or spray plants with BTK if many caterpillars are feeding.

Flower and Fruit Problems

Few flowers form; flowers may drop without setting fruit. Causes: Excess nitrogen; extreme temperatures; pepper weevils. Plants with excess nitrogen are dark green and vigorous, but produce few flowers. Wait for flowers to form. Prevent problems by avoiding high-nitrogen soil amendments.

Temperatures over 85° or below 60°F can damage flowers and cause them to fall without setting fruit. Wait for new flowers to form. Protect plants with row cover until night temperatures remain above 60°F.

Check flowers for pepper weevils, which are ⅛", reddish brown to black insects. These pests may also cause misshapen and discolored fruit. Destroy infested fruit; dust with pyrethrin as a last resort.

Fruit misshapen. Causes: Extreme temperatures; pepper maggots; viral diseases. Temperatures over 85° or below 60°F can damage flowers and prevent complete pollination. Resulting fruit is lopsided and deformed, but ripens evenly.

Pepper maggots are white with pale heads and grow up to ¼" long. Adults are small yellow-and-brown flies. Ripening fruit is blotchy. Destroy infested fruit. Spray plants with pyrethrin when they begin to set fruit, and repeat if damage occurs if you have had severe problems in the past.

If ripening fruit is blotchy but no maggot feeding is found, the plants may have a virus. See "Leaves mottled with yellow; young growth malformed" above for controls.

Fruit with green to dark brown, raised, wartlike spots. Cause: Bacterial spot. Spots can provide entry for more destructive rot fungi in wet weather. Spotted fruit is edible if not rotted. See "Leaves with small, sunken, yellow-green spots" above for controls.

Fruit with small, rotten spots or shallow depressions. Cause: Pepper maggots. See "Fruit misshapen" above for description and controls.

Fruit with faded or gray-white, sunken patches or pits. Causes: Sunscald; cold injury. Green or ripe fruit can be sunscalded. Damage shows up as a large, sunken patch on the exposed side. Patches turn dry and may develop black mold. Control leaf diseases to prevent defoliation, so fruit will be shaded and protected from direct sun. Stake plants.

Pepper fruits are damaged by temperatures below 37°F and develop small, sunken pits or large, discolored areas. Cover plants with row cover if temperatures near freezing are predicted.

Fruit with water-soaked, sunken areas at the blossom end. Cause: Blossom end rot. Seen on green or ripe fruit. Affected area becomes dark and shriveled. This condition is caused by calcium deficiency in the fruit. It is aggravated by drought or uneven soil moisture, root damage, high salt levels in the soil, and excess nitrogen. If soil test indicates deficiency, add high-calcium lime to the soil. Prevent

problems by keeping soil evenly moist and by spraying plants with seaweed extract when the first flowers open and again when green fruit is visible.

Fruit with water-soaked areas near stem; entire fruit collapses into a slimy mess. Cause: Bacterial soft rot. Pick fruit as soon as water-soaked areas appear, and discard soft portions. Destroy rotted fruit. Prevent problems by controlling insect damage, staking and spacing plants so they dry out rapidly, and mulching to prevent soilborne bacteria from splashing up on plants during watering. Spray fruiting plants with copper if the weather is wet and you have had severe problems in the past.

Fruit with concentrically ringed, sunken spots. Cause: Anthracnose. Spots appear on green or ripe fruit. Destroy infected fruit. Spray fruit with copper when they are almost full-size and begin to feel solid if you have had problems in the past. Presoak seed in a 10 percent bleach solution to prevent seed-borne disease.

Fruit colors prematurely; small holes and sawdustlike material visible near stems. Causes: European corn borers; corn earworms. Once caterpillars are feeding in fruit, it is too late to control them by spraying. Pick and use or destroy infested fruit. Both of these pests feed on leaves for a few days before they enter fruit, so reduce damage by spraying plants with BTK if caterpillars are feeding on leaves. Prevent adults from laying eggs on plants by covering them with row cover.

Perennials

Pests and diseases that trouble ornamental perennial plants may warrant different treatment than those same problems appearing on annuals. Perennials are plants you hope to have around for a long time, so eliminating hungry insects and disfiguring diseases becomes more important. With few exceptions, the pests and diseases that plague perennials are best controlled through good site selection and cultural practices, as described in the individual plant entries.

The symptoms listed below represent damage caused by pests and diseases that attack a wide variety of herbaceous perennials. Controls for these problems do not vary significantly among plant species.

Problems

Leaves and/or flowers with holes. Causes: Japanese beetles; other leaf-eating beetles. Perennial beds attract a number of hungry beetles, including ¾" black blister beetles, 1/10" flea beetles, 1/3", reddish brown rose chafers, and nocturnal, 1/3", gray Fuller rose beetles. Iridescent blue-green with bronze wing covers, ½" Japanese beetles top this list of troublesome pests; the adults devour the leaves, stalks, and flowers of nearly 300 plant species, while the ¾", C-shaped grub larvae feed on roots and are a major pest of lawn grasses.

Injury caused by adult beetles ranges from small holes in leaves to skeletonized foliage to complete defoliation. Feeding by weevils, such as long-nosed Fuller rose beetles, resembles "ticket punches" around leaf margins. Japanese beetles are fond of flowers and often do most of their damage there. Most beetles are active during the day and are large enough to be readily visible while they feed. Weevils more often prefer night-time feeding; a flashlight reveals their activity.

Handpick adult beetles into a can of soapy water or a 5 percent solution of isopropyl alcohol. Wear gloves if your pests are blister beetles; contact with crushed beetles can cause burns and blisters on skin. Shake infested plants in early morning to knock beetles onto a dropcloth, then scoop them up and destroy.

Coordinate a community effort to set up Japanese beetle traps over a large area; otherwise, traps will just attract these pests to your yard. Treat lawns with milky disease spores to control beetle larvae. Apply parasitic nematodes to the soil to limit all beetle grub populations. As a last resort, spray infested plants with neem or pyrethrin.

Leaves with large, ragged holes. Cause: Slugs and snails. Differing only in the presence or absence of a shell, slugs and snails range in size from ⅛" to 8" and may be gray, tan, green, black, yellow, or spotted. The cool, moist soil conditions favored by many perennials make plantings appealing to these busy mollusks. Mulch and plants with low-growing leaves provide shady hiding places from which they emerge to feed nocturnally. All species rasp large holes in leaves, stems, and bulbs; slimy trails of mucus also signal their presence.

Since slugs and snails travel on a flat, muscular foot, you can impede their progress with barriers of materials that irritate their soft bodies. Push 4"-8" copper strips into the soil around beds as edging. Sprinkle bands of coarse, dry, scratchy materials such as cinders, wood ashes, cedar sawdust, and diatomaceous earth around plants or beds; renew frequently. Lay boards, cabbage leaves, or overturned clay pots—anything that offers a cool, damp daytime haven—around the garden; destroy pests that congregate underneath. Handpick slugs and snails from plants at night; kill the pests by dropping them into soapy water or sprinkling them with table salt. Set shallow pans into the soil, placing the lip flush with the soil surface, and fill with stale beer or any fermenting liquid; remove drowned pests daily. Encourage predatory ground beetles by maintaining clover, sod, or stone walkways.

Leaves, stems, and buds distorted, sticky; clusters of small insects. Cause: Aphids. Several species of pear-shaped, 1/32"-⅛" aphids plague perennials. Aphids can be green, pink, black, gray, or with a white fluffy coating and have long antennae and 2 short tubes projecting from the rear of their abdomens. These pests cluster under leaves and on growing tips. Aphids suck plant sap, causing leaf and bud distortion and blossom and leaf drop. Their feeding may spread diseases such as aster yellows. As they feed, they excrete sticky honeydew on which sooty mold grows; see "Leaves with black coating" below for more information.

Wash aphids from plants with a strong spray of water; repeat as needed to control infestations. Encourage natural predators and parasites such as aphid midges, assassin bugs, lacewings, lady beetles, and spiders. Apply homemade garlic or tomato-leaf sprays. If water sprays fail, try sprays of alcohol, citrus oil, insecticidal soap, or neem. Use boric acid bait to control ants that herd aphids onto plants. As a last resort, spray seriously infested plants with pyrethrin.

Leaves with black coating. Cause: Sooty mold. This fungus grows on the sugary, sticky honeydew produced by aphids and other sucking pests such as scales, whiteflies, and mealybugs. The black fungal coating doesn't harm leaves directly, but it does shade the leaves and reduce growth. The best control is to deal with the pests that are producing the honeydew. Identify the pest and apply the appropriate control. (If the plant itself doesn't show signs of pest damage, the honeydew may be dripping down from an overhanging plant.) On small plants, wipe the leaves with a damp cloth to remove the honeydew and the sooty mold.

Leaves covered with white powder. Cause: Powdery mildew. Powdery white or grayish fungal patches grow on upper leaf surfaces of plants subject to poor air circulation or hot, humid weather. As the disease spreads, leaves become distorted and may drop off. Powdery mildew is more severe when growing conditions are unsatisfactory.

To prevent powdery mildew, spray with sulfur fungicide approximately every 10 days during warm, wet weather. If infection occurs, remove and destroy infected leaves. Water early in the day so foliage dries before nightfall. Avoid wetting leaves when watering. Thin plants to improve air movement. Avoid ongoing problems by cleaning up debris in the fall and destroying severely infected plants. To protect plants, spray with antitranspirants, baking soda solution, a commercial fungicidal soap, garlic, copper, or sulfur.

Buds and leaves deformed or dwarfed. Cause: True bugs. Several of the generally shield-shaped true bugs (order Hemiptera), including tarnished plant bugs, four-lined plant bugs, lace bugs, and lygus bugs, feed on perennials. While many species of true bugs are beneficial insects, the pests in this group pierce plant tissue to drink sap, injecting toxins that deform plant tissues. In addition to dwarfing and deforming plants, feeding by true bugs causes sunken, rounded, tan to dark brown spots on foliage. As leaves grow, the dead areas tear into small holes.

Many of these pests overwinter in garden refuse; remove weeds and debris from area in spring and fall. Plant groundcovers and pollen plants to encourage populations of predatory insects. Handpick pests and drop them into a jar of soapy water. Spray every 3-5 days with insecticidal soap, making sure to treat the undersides of leaves, for 2 weeks. Treat severe infestations with pyrethrin.

Seedlings or young plants cut off at soil level. Cause: Cutworms. The fat, gray or dull brown, 1″ caterpillars of 1½″ brown or gray moths, cutworms feed on stems at night, cutting off transplants and sometimes eating entire seedlings. Severed plants are found lying on the ground the next morning. Some species climb plant stems, cutting off leaves and sideshoots as they feed. Most active in May and June, cutworms can destroy several plants each night. These caterpillars remain below the soil surface during the day.

Protect plants by placing a collar, such as a toilet paper roll or an open-ended can, around each young plant. Make each collar 2″-3″ wide and 1½″-2″ in diameter; push them into the soil so that about half the collar is below the soil surface. To kill some larvae, scatter moist bran mixed with molasses and BTK over soil in the evening a week before planting. Also, apply parasitic nematodes to the soil to reduce future populations.

Petunia

Petunia. Annuals.

Showy petunias are popular in bedding schemes all over the country. Single or double, plain or ruffled, trumpet-shaped flowers bloom all summer on 8″-18″ plants. Flower colors include lavender, yellow, red, pink, purple, and white, alone or in combinations. Plant in masses for eye-catching effect in beds, borders, containers, or hanging baskets.

Sow seed indoors 9 weeks before the last frost. Do not cover the extremely tiny seeds. Transplant carefully outdoors when frost danger passes. Many gardeners prefer to buy bedding plants. Get sturdy young plants, not leggy ones that won't grow well.

Single-flowered cultivars do well in average soil and are hardier in general; fancy ruffled types grow best in richer soil. Petunias need sunshine at least half the day, and prefer more. Water frequently during hot weather. Monthly light feedings encourage bigger and better flowers; overfertilization gives stem and leaf growth rather than blooms. In midsummer plants may begin looking straggly. Cut back to 6″ high, fertilize, and give a good soaking to revitalize.

Problems

Flowers with gray or brown spots; leaves with brown spots. Cause: Botrytis blight. This fungus is a real problem in humid climates. As the fungus spreads, the spots may become fuzzy with mold. The initial attack is on weak plants but spreads to healthy ones on contact, or by wind, rain, or handling. Remove infected flowers and leaves. Thin plantings to improve air circulation. Use drip irrigation rather than overhead watering. Look for Botrytis-resistant cultivars.

Leaves mottled and crinkled. Cause: Viral diseases. Several viruses can attack petunias. They are spread by contact or by insects, such as aphids and leafhoppers. Remove and destroy infected plants. Wash your gardening tools and hands after touching infected plants. Also, don't smoke in the garden, to avoid introducing viruses from the tobacco.

Leaves and/or flowers with round or irregular holes. Causes: Caterpillars; beetles; slugs and snails. Both moth and butterfly caterpillars feed on petunia leaves and buds. Handpick, or spray with BTK on appearance. Many types of beetles, including flea beetles, Japanese beetles, Colorado potato beetles, and cucumber beetles, feed on petunias. Handpick larger beetles. For serious infestations, apply pyrethrin in early morning. Slugs and snails like petunias, too. For control information, see "Leaves with large, ragged holes" on page 18.

Philadelphus

Mock orange. Shrubs.

Mock oranges are deciduous shrubs, grown primarily for their white, late-spring flowers. They are useful in shrub borders.

Set out in fall or spring in full sun or light shade. While they can adapt to varying soil conditions, mock oranges prefer a moist but well-drained site rich in organic matter.

Mock oranges are remarkably free of serious problems. Aphids sometimes infest the leaves; see "Leaves wrinkled and discolored" on page 235 for controls. Leafminer larvae make curved mines in the leaves; see "Leaves tunneled" on page 237. Plants crowded together are susceptible to powdery mildew; for controls, see "Leaves with powdery white coating" on page 237.

Phlox

Phlox. Perennials.

Showy, long-flowering plants that produce clusters of trumpet-shaped blooms in many colors, phlox range from tall, upright plants to low, trailing ones. Bountiful flowers of white, purple, pink, and blue—often with contrasting centers—cover the various species: Garden phlox (*Phlox paniculata*) grows 3'-4' tall and blooms mid- to late summer; creeping phlox (*P. stolonifera*) is a 9"-12" spring bloomer; 5"-6" tall moss pink (*P. subulata*) flowers in early spring. Lance-shaped, 3" long, light green leaves are typical of most phlox, although moss pink's fine, semi-evergreen foliage is needlelike.

In general, plant upright phlox in full sun and give trailing species partial shade. Garden phlox tolerates light shade, but weaker plants result. Moist, well-drained, and richly organic soils are favored by all phlox; add compost to soil at planting. Choose sites with good air movement to limit diseases; taller phlox need shelter from wind and may require staking. Phlox do not endure drought well;

give ½"-1" of water weekly, applying it at soil level to avoid wetting leaves. Mulch to retain moisture in summer.

Remove spent flowers to prolong blooming and reduce seed set. Seedlings gradually take over garden phlox plantings if plants are allowed to self-sow; flower color and plant size may change dramatically over time, as seedlings are not true to parents. Shear low-growing moss pink back by half to encourage bushy growth. Divide as necessary to improve air circulation and reduce clumps.

The severity of pest and disease attacks varies among phlox species; most are durable plants that easily withstand problems. Garden phlox, however, is injured by a number of pest and disease organisms, as described below.

Problems

Buds and leaves deformed or dwarfed. Cause: Phlox plant bugs. See "Buds and leaves deformed or dwarfed" on page 178.

Leaves covered with white powder. Cause: Powdery mildew. See "Leaves covered with white powder" on page 177 for controls.

Leaves deformed; stems swollen or deformed; plant stunted. Cause: Bulb and stem nematodes. Plants infested with these tiny roundworms have crinkled, thin, or thread-like leaves, distorted shoot tips, and swollen stems. Stunted plants fail to flower and may die. Nematodes travel over wet plants on a film of water or on garden tools and gardeners moving among plants. There is no cure for infested plants; remove and destroy them. Do not grow phlox in sites where nematodes are present. Remove debris from gardens in fall to control pest populations.

Leaves stippled, reddish to yellow, with fine webbing. Cause: Spider mites. These 1/50" pests feed on the undersides of foliage, causing it to yellow, dry up, and die; excessive feeding turns foliage almost white, and fine webs appear on leaves. Mites seek out water-stressed plants in hot, dry weather; adequate watering guards against these pests. While spraying plants daily with a strong stream of water often gives control, this practice promotes fungal leaf disorders in phlox. Introduce predatory mites to the garden (1,000 per 500 square feet). Spray severe cases with avermectins, citrus oils, insecticidal soap, neem, or pyrethrin.

Leaves with brown spots. Cause: Fungal diseases. Several fungi cause leaf spots that enlarge, run together, and form blotches. Don't overcrowd plants; avoid working with phlox when leaves are wet; remove and destroy infected plant parts and severely infected plants. If leaf spots are a regular problem, spray with sulfur or bordeaux mix.

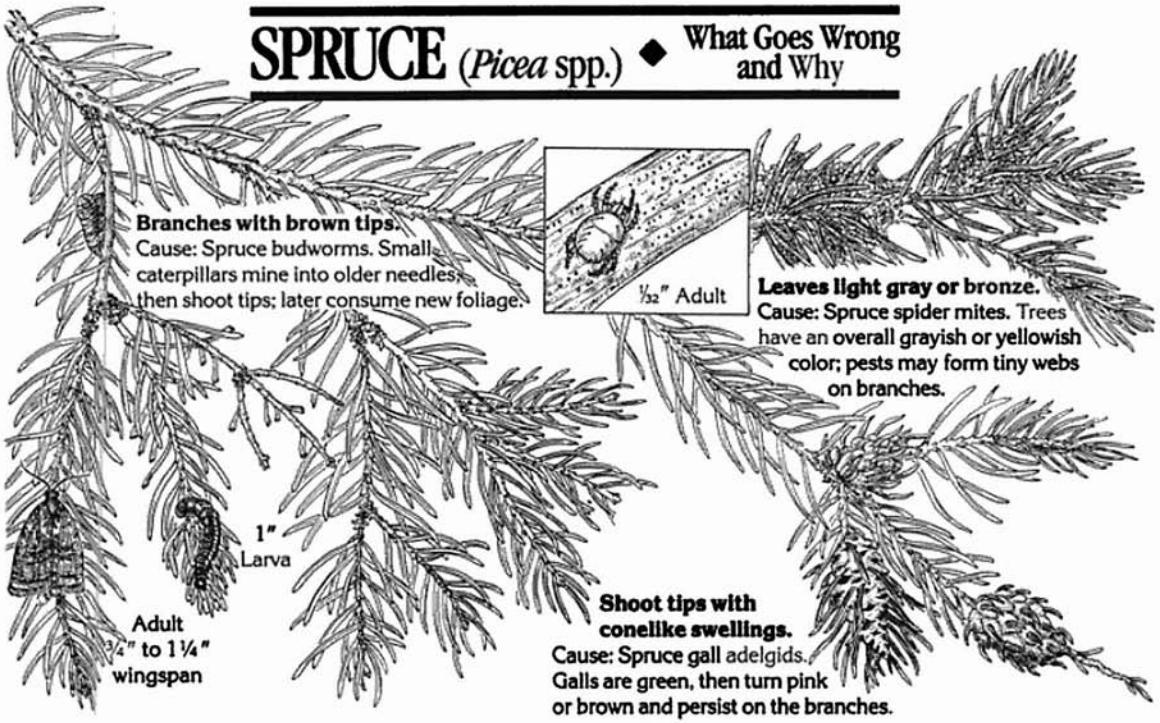
Picea

Spruce. Trees.

Spruces are evergreen, needle-leaved, cone-bearing trees. In general, they grow as rigidly upright, pyramidal trees, reaching more than 100' in height. They make impressive specimen trees on large properties. Their large size, formal habit, and tendency to lose their lower branches make spruces less desirable for the average home landscape.

Before you plant a spruce, be sure you have enough room to let the tree reach its normal size; it may be small when you bring it home, but it will grow surprisingly fast! Set out in spring as balled-and-burlapped plants on a sunny or lightly shaded site. Spruces need a moist but well-drained, slightly acid soil with lots of organic matter. They grow best in cool, northern climates.

Caution: When controlling pests, be aware


SPRUCE (Picea spp.) ◆ What Goes Wrong and Why
Branches with brown tips.
Cause: Spruce budworms. Small caterpillars mine into older needles; then shoot tips; later consume new foliage.
1/32" Adult
Leaves light gray or bronze.
Cause: Spruce spider mites. Trees have an overall grayish or yellowish color; pests may form tiny webs on branches.
1"
Larva
Adult
3/4" to 1 1/4"
wingspan
Shoot tips with conelike swellings.
Cause: Spruce gall adelgids. Galls are green, then turn pink or brown and persist on the branches.

that oil sprays will remove the blue color from the foliage of blue spruces until new normal foliage is produced. Other spruce species may also be sensitive to oil sprays; read the product label, apply at a reduced rate if recommended, and test spray on a branch before treating the whole plant.

Problems

Branches with brown tips. Cause: Spruce budworms. This pest is widely distributed over the northern United States. The brown, 1" caterpillars have 2 rows of white dots along their backs; they tunnel into opening buds, destroying the terminals and gradually migrating to the younger foliage, leaving the tree looking as if it had been swept by fire. See above for an illustration of this pest.

Handpicking works if only a few caterpillars are present; usually, however, they are so numerous as to require an application of BTK. Remember to reapply after rain.

Leaves light gray or bronze. Cause: Spruce spider mites. These tiny, spiderlike pests damage needles as they feed; the injury weakens the plant and can kill young trees. Mites start feeding on lower, older needles and progress upward and outward; tiny webs may be visible on needles. See above for an illustration of this pest.

Control in spring with dormant oil before growth starts; see caution above before spraying. During active growth, spray plants repeatedly with strong jets of water. For severe

infestations, make 2 applications of insecticidal soap 7-10 days apart, or apply pyrethrin as a last resort.

Shoot tips with conelike swellings. Cause: Spruce gall adelgids. The pests themselves are seldom seen; in the spring the young insects feed on the new needles, causing the spruce to produce galls that enclose the pests. The adelgids mature in the galls, and the adults emerge in mid- to late summer. They overwinter as nymphs or adults. See page 181 for an illustration of this pest.

If there are only a few galls, prune them off before they open in July. For serious infestations, spray the plant with insecticidal soap as new growth starts the following spring. Or apply a dormant oil spray over the whole plant in late winter to kill overwintering pests; see caution above before spraying.

Leaves discolored; branch tips webbed. Cause: Spruce needleminers. The ½", greenish caterpillars feed at the base of needles, mining as they go, and sometimes web together the needles at the tips of twigs. Control by spraying the plant with a strong blast of water in fall or late winter to knock the webs and loose needles from the tree; then clean up all fallen debris.

Plant defoliated; branches bear cocoonlike bags. Cause: Bagworms. For controls, see "Plant defoliated; branches bear cocoonlike bags" on page 236.

Plant defoliated. Causes: Gypsy moths; sawflies. See "Plant defoliated" or "Leaves skeletonized" on page 236 for controls.

Terminal shoot curled and brown. Cause: White pine weevils. For more information, see "Terminal shoot curled and brown" on page 183.

Trunk or branches with small holes; limbs die or break off. Cause: Borers. For controls, see "Trunk or branches with small holes; limbs die or break off" on page 238.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. See "Leaves yellow; stems and leaves covered with small bumps" on page 237 for controls.

Trunk or branches with oozing lesions; branch tips die back. Cause: Canker. For more information, see "Trunk or branches with oozing lesions; branch tips die back" on page 238.

Branch tips die back. Cause: Blight. This fungal disease attacks mostly during cool, wet weather. Good air circulation among trees discourages its onset. Leaves of infected plants shrivel and twigs die back. Cut off and destroy dead or diseased wood. In a very cool, wet spring, you can spray with bordeaux mix, starting when new growth appears on the trees and repeating at 2-week intervals until the weather gets warmer and drier.

Leaves yellow and drop. Cause: Rust. Whitish blisters on the undersides of the leaves followed by yellowing and leaf drop indicates rust. Prune out and destroy infected branch tips. To reduce the spread of mild infections, spray with sulfur, repeating 2 or 3 times at weekly intervals.

Pieris

Pieris. Shrubs.

Pieris are broad-leaved, evergreen shrubs. The waxy, white flowers are borne in terminal clusters and open in early spring. Pieris are used in foundation plantings and are ideal for woodland gardens.

Set out in spring as balled-and-burlapped or container-grown plants. Moist but well-drained, acid soils with lots of organic matter suit them best. Apply an organic mulch to keep down weeds and maintain a cool, moist

root zone. Pieris thrive in sun or partial shade; plants will survive in dense shade, but flower less.

Pieris are subject to some of the insects and diseases that attack rhododendron; see the Rhododendron entry beginning on page 200 for symptoms and controls.

Pinus

Pine. Shrubs and trees.

Pines are needle-leaved, cone-bearing evergreens important both for their wood and ornamental value. In the landscape, some are useful as informal screens, others as hedges and foundation plants, and the more picturesque ones as specimens in the lawn or rock garden.

Set out in spring as balled-and-burlapped plants. A well-drained, somewhat acid soil enriched with organic matter suits them best. Pines prefer full sun, but will grow, although with a somewhat more open habit, in partial shade.

Problems

Branches dead; bark with yellow-orange blisters. Cause: White pine blister rust. This fungal disease needs 2 kinds of plants to complete its life cycle: a pine and a currant or gooseberry plant. While it does little damage to currants or gooseberries, this disease can quickly kill infected pines. It enters through the needles and grows into the bark, where it causes cankers that can girdle stems and branches. These cankers develop orange-yellow blisters that release spores. See page 184 for an illustration of these symptoms.

Avoid planting white or other 5-needled pines within 200 feet of currants or gooseberries. For other controls, see "Trunk or branches with oozing lesions; branch tips die back" on page 238.

Leaves brown at base; shoots ooze resin. Cause: Tip blight. This fungal disease causes needles to brown in early and midsummer, when they are about half their normal size. Entire shoot tips may be killed, most commonly on lower branches. Resin oozing from infected twigs is another common symptom. See page 184 for an illustration of these symptoms.

Tip blight most commonly attacks old or stressed trees. To avoid problems, keep plants growing vigorously with proper pruning, mulching, and watering (during drought). Remove the source of infection by pruning out dead branches during dry autumn weather. (Sterilize pruners between cuts in a solution of 1 part bleach to 9 parts water.) Also clean up fallen cones and other debris around the base of the tree. The following spring, spray with bordeaux mix when the new shoots start to grow; repeat when the shoots are half-grown and again 2 weeks later.

Branches with brown tips. Causes: Pine tip and pine shoot moths; spruce budworms. For an illustration of pine shoot moths, see page 184; for spruce budworms, see page 181.

The larvae of these pests all cause similar damage, boring into the bases of needles and tunneling into shoot tips all over the plant. Their damage differs from that of white pine weevils in that the weevils only attack the top shoot (leader) of a plant. Handpicking works if only a few caterpillars are present. Pruning off and destroying infested tips in winter is a very effective control. Spraying with BTK before the caterpillars enter the shoots may be effective.

Terminal shoot curled and brown. Cause: White pine weevils. The 1/3", pale yellow larvae bore into the terminal shoot, distorting and eventually killing it. The 1/4", mottled brown adult weevils emerge in late summer to feed

PINE (Pinus spp.) ◆ What Goes Wrong and Why
7/8"
Larvae
Plant defoliated. Cause: Sawflies. The caterpillar-like larvae eat old and new foliage; shoot tips may be left bare.
Leaves brown at base; shoots ooze resin. Cause: Tip blight. Resin holds dead needles in place; disease attacks lower branches first, then moves upward.
3/4"
Larva
Adult
3/4" wingspan
Branches with brown tips. Cause: Pine shoot moths. Larvae burrow in stem tips, which continue growing but are deformed.
Branches dead; bark with yellow-orange blisters. Cause: White pine blister rust. Blisters seep resin and eventually spread to the trunk, girdling it.

on buds and bark. Reduce populations of adults by spraying weekly with pyrethrin as long as adults are visible. Early in the season, cut off damaged shoots several inches below the affected area. To replace the damaged leader, select a horizontal branch right below the cut and fasten it to a stake in an upright position.

Bark damaged; leaves yellowish. Causes: Beetles; weevils; pine bark adelgids. A wide variety of pests attack the bark of pines. Beetles and weevils make small holes in the trunk where they bore through the bark and tunnel underneath. Pine bark adelgids are small, cottony, white insects that congregate on the bark of the trunk and limbs.

Beetles and weevils most commonly attack already stressed trees, so the best control for these pests is prevention. Keep trees growing vigorously by watering during dry spells; fertilize if plants are injured or stressed.

Control adelgids by spraying the plant several times, a day or two apart, with a strong blast of water. For more serious infestations, spray the trunk and branches with insecticidal soap every 3 days until the pests are gone.

Leaves light gray or bronze. Cause: Spruce spider mites. For an illustration of this pest, see page 181. For control measures, see "Leaves light gray or bronze" on page 181.

Leaves discolored and drop. Cause: Needlecasts. Several kinds of fungi attack pine foliage, causing spots or bands or total browning of the needles. These symptoms usually appear in early spring the year after the needles are infected. Planting trees where they will have good air circulation is the best way to avoid problems. Cleaning up fallen needles and pruning out damaged tips will help reduce the source of infection. To avoid symptoms the following year, spray with bordeaux mix

when the new shoots are half-grown; repeat 2 weeks later.

Trunk or branches with oozing lesions; branch tips die back. Cause: Canker. Several kinds of fungi cause cankers on pines. For more information, see "Trunk or branches with oozing lesions; branch tips die back" on page 238.

Leaves skeletonized or with large holes; branches may be webbed. Cause: Caterpillars. Several kinds of caterpillars feed on pines. For control information, see "Leaves skeletonized or with large holes; branches may be webbed" and "Plant defoliated" on page 236.

Plant defoliated. Cause: Sawflies. Several species of sawflies cause similar damage in midsummer or early fall. For an illustration of the pests and their damage, see the opposite page. Natural parasites usually keep them in check. If necessary, handpick the white, green, or brown, caterpillar-like larvae. For severe infestations, spray the plant with insecticidal soap, or pyrethrin as a last resort.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. See "Leaves yellow; stems and leaves covered with small bumps" on page 237.

Plant defoliated; branches bear cocoonlike bags. Cause: Bagworms. For control measures, see "Plant defoliated; branches bear cocoonlike bags" on page 236.

Trunk or branches with small holes; limbs die or break off. Cause: Borers. For more information, see "Trunk or branches with small holes; limbs die or break off" on page 238.

Leaves tunneled. Cause: Leafminers. The brown larvae of the pine leafminers enter the leaves and excavate them. Injured tips turn yellow and dry up. See "Leaves tunneled" on page 237 for control measures.

Branches with knotlike swellings. Cause: Gall rusts. Large galls, up to several inches in diameter, form on branches and eventually release yellowish spores. Pine-pine gall rusts produce spores that only infect pines; pine-oak gall rusts also attack oak trees, causing galls on their leaves. Control both kinds by pruning the galls from pine trees as soon as you spot them.

Leaves yellow and wilt. Cause: Root rot. For more information, see "Leaves yellow and wilt" on page 237.

Platanus

Sycamore, planetree. Trees.

Sycamores are deciduous, alternate-leaved trees with colorful, exfoliating bark and ball-shaped fruit. They are widely used as street trees since they withstand urban conditions.

Set out sycamores in spring or fall, planting in full sun or very light shade. They are remarkably tolerant of a range of soil conditions.

Problems

Leaves and shoots blackened; leaves with moist or brown sunken spots. Cause: Anthracnose. This fungal disease is very common on American planetree (*Platanus occidentalis*); London planetree (*P.* × *acerifolia*) is generally more resistant. For control information, see "Leaves and shoots blackened; leaves with moist or brown sunken spots" on page 238.

Trunk and branches with elongated, sunken, cracked areas; leaves yellow or sparse. Cause: Canker stain. This is a serious disease that can spread quickly, girdling and killing branches or the whole tree. Remove and destroy seriously affected trees. Prevention is the best control; avoid creating any wounds that allow the disease to enter the tree. Summer pruning, for example, often encourages canker stain on the branches; winter pruning is best. Also, be careful when using lawn mowers or other equipment around the tree to avoid damage to the trunk.

Leaves stippled with red or yellow spots. Cause: Sycamore lace bugs. This widespread and serious pest feeds on the undersides of planetree foliage. As the 1/10", silvery white lace bugs feed, they puncture the leaves and then exude a toxin that turns the area around these punctures red or yellow. Spraying leaves with insecticidal soap just after the leaves unfold should control this pest.

Leaves with powdery white coating. Cause: Powdery mildew. For control information, see "Leaves with powdery white coating" on page 237.

Trunk or branches with oozing lesions; branch tips die back. Cause: Canker. See "Trunk or branches with oozing lesions; branch tips die back" on page 238.

Leaves with spots. Cause: Leaf spots. See "Leaves with spots" on page 237.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. Heavy infestations can seriously weaken the tree; see "Leaves yellow; stems and leaves covered with small bumps" on page 237 for controls.

Trunk with shelflike growths. Cause: Wood rots. A number of fungus-caused wood rots can occur; see "Trunk with shelflike growths" on page 238.

Plum

Prunus spp. (Rosaceae)

Plums are deciduous trees that grow from 5′ to 20′ depending on soil, rootstock, and cultivar. Japanese plums (*Prunus salicina*) bear fruit on spurs—short branches that elongate only a fraction of an inch per year—1 year old or older. European (*P. domestica*) and hybrid plums bear fruit on spurs 2 years old or older. Plums are hardy in Zones 4-10, depending on species and cultivar.

Plant plums in a well-drained, sunny site free of late spring frosts. Prune European plums to a central leader and Japanese plums to a modified central leader (see the illustration on page 102). For more pruning information, see "Pruning and Training" on page 101. Some plums need cross-pollination; for more information, see "Setting Fruit" on page 101.

Fruit Problems

Young fruit with crescent-shaped scars. Cause: Plum curculios. These beetles appear around bloom time and leave a characteristic scar as they lay eggs in fruit. Infested fruit usually drops. Egg-laying ceases by early summer, but insects return later in the season to feed.

Botanical sprays don't control curculios adequately. To control this pest, spread a drop-cloth beneath the tree and jar it with a padded mallet. Collect and destroy curculios that fall onto the sheet. For best results, jar the tree twice a day, beginning as soon as you see the first scarred fruit. In addition, collect and discard dropped fruit to prevent newly laid eggs from hatching. A traditional control is to keep chickens beneath the trees to consume adult curculios and grubs from fallen fruit.

Fruit with small brown spots that enlarge and grow fuzzy in humid weather. Cause: Brown rot. Leaves and flowers may also turn brown. The cultivars 'AU-Rosa' and 'Crimson' resist this fungus. For more information, see "Fruit with small brown spots that enlarge and grow fuzzy in humid weather" on page 166.

Fruit with brown, sunken spots on the surface. Cause: Bacterial leaf spot. Brown or black angular leaf spots may also appear. This disease isn't curable, although copper spray offers partial control. Resistant cultivars include 'AU-Amber', 'Crimson', and 'Simon'. For more information and control measures, see "Fruit with small, dark, sunken spots or cracks on skin" on page 166.

Leaf and Branch Problems

New leaves twisted or curled and covered with a sticky coating. Cause: Aphids. For heavy infestations, apply a strong spray of water or insecticidal soap solution to trees. For more control information, see "New leaves twisted or curled and covered with a sticky coating" on page 67.

Twigs and branches bearing tarry, black galls. Cause: Black knot. To control this fungal gall, prune out branches a few inches below galls. Resistant cultivars include 'AU-Producer,' 'Crimson', 'Milton', 'President', and 'Shiro'.

Branches wilting and dying, fail to leaf out in spring. Causes: Bacterial canker; Valsa canker. Look on the branches for sunken, elliptical lesions, often oozing a reddish gum. For more information and controls for these diseases, see "Branches wilting and dying, fail to leaf out in spring" on page 167. The cultivars 'AU-Amber', 'California', 'Crimson', 'Duarte', 'Homeside', and 'President' are resistant. 'Myrobalan' rootstock confers some resistance.

Tree stunted or dying. Cause: Plum leaf scale. This disease is common in the Southeast. There is no cure. Dig up infected plants and replant with a resistant cultivar such as 'AU-Rosa' or 'AU-Amber'.

Populus

Poplar. Trees.

Poplars are deciduous trees, generally fast-growing and weak-wooded. Male and female flowers appear on different plants. Females produce cottony seeds, so choose male cultivars to minimize the mess.

Easy to grow, poplars need full sun but can adapt to a range of soil conditions. They have spreading roots that can invade drains and water pipes; make sure you site plants away from these features. The extensive root system makes poplars tolerant of drought. These trees are naturally short-lived and are prone to many pest problems.

Problems

Trunk or branches with oozing lesions; branch tips die back. Cause: Canker. This is a widespread and serious problem on poplars. For more information, see "Trunk or branches with oozing lesions; branch tips die back" on page 238.

Trunk or branches with small holes; limbs die or break off. Cause: Borers. A number of different borers attack poplars; see "Trunk or branches with small holes; limbs die or break off" on page 238 for controls.

Leaves skeletonized or with large holes; foliage may be webbed. Cause: Caterpillars. For control information, see "Leaves skeletonized or with large holes; foliage may be webbed" on page 236.

Leaves with powdery white coating. Cause: Powdery mildew. See "Leaves with powdery white coating" on page 237.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. For controls, see "Leaves yellow; stems and leaves covered with small bumps" on page 237.

Leaves wrinkled and discolored. Cause: Aphids. See "Leaves wrinkled and discolored" on page 235 for controls.

Portulaca

Moss rose, garden portulaca. Annuals.

These bright-flowered, mat-forming annuals come in several colors, including red, purple, pink, white, and yellow. The ruffled flowers

are 1" wide. Plants grow 4"-8" high and can spread to 1½'. Flowers open in sunlight and close with dusk or cloudy skies.

Sow seed indoors 7 weeks before the last frost date. Set plants out in late spring when the soil is warm. Direct-seed outdoors in warm soil and full sun after last frost. Mix the tiny seed with sand to get an even distribution. Press seeds down firmly, but don't bury them. Water gently, keeping the soil moist until seedlings appear (about 10 days).

Drought-tolerant moss rose thrives in rocky soil or sand. It enjoys full sun, high temperatures, and good drainage. Pests and diseases are seldom a problem.

Potato

Solanum tuberosum (Solanaceae)

Potatoes are annual vegetables grown for their nutritious, starchy tubers. They are commonly known as white potatoes, but different cultivars have white, yellow, pink, or even bluish flesh, and yellow, brown, red, or purple skin.

Culture

Potatoes require deeply worked, well-drained soil with lots of organic matter, and a pH between 5.0 and 6.8. Potatoes require moderate to high levels of nitrogen, phosphorus, potassium, calcium, and sulfur. Have the soil tested and amend as needed before planting. Gypsum is a good source of calcium and sulfur for potatoes.

Keep soil moist, but not soggy, and do not allow it to dry out. Alternating dry and wet soil can cause cracked or knobby tubers. Once tops begin to yellow near harvest, you can let the soil dry out without damaging tubers.

Do not plant potatoes where tomatoes, potatoes, eggplants, peppers, strawberries, or brambles have been planted within the past 4-5 years. Also, try to plan your planting scheme to separate these crops in the garden. Don't plant potatoes where sod or small grains were grown the previous year: Wireworms, a common sod pest, also feed on potato tubers. Compost or till under all plant residues at the end of the season. Tilling the soil helps prevent pests from overwintering.

Potatoes are usually grown from seed potatoes (tubers) or "buds" (tiny tissue-cultured tubers), but a few cultivars, such as 'Explorer' and 'Homestead Hybrid', are grown from true seeds. Prevent problems by planting only certified disease-free tubers. Planting true seeds or buds also helps avoid many tuber-borne diseases.

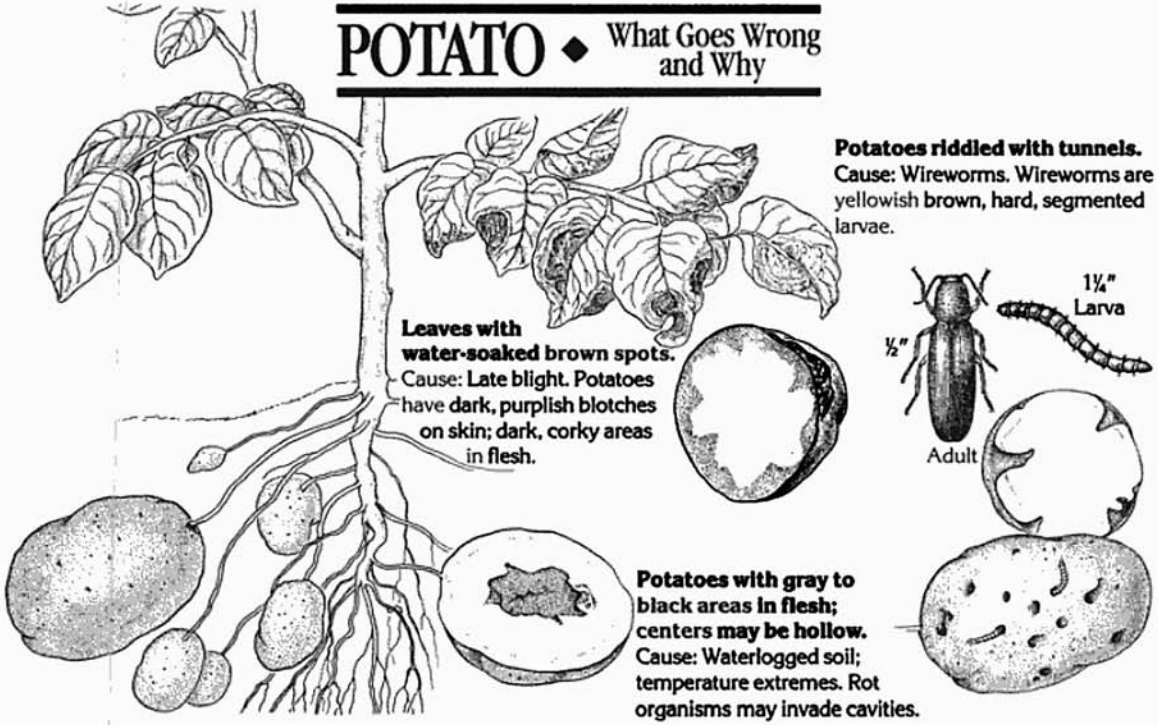
Pre-condition tubers by storing them between 65° and 70°F for 2 weeks before planting to encourage rapid growth. Soak pieces in compost tea for several hours before planting to help prevent disease problems. Plant them out when soil is at least 40°F.

Leaf and Whole Plant Problems

Sprouts fail to emerge; seed pieces rot. Cause: Various fungal and bacterial rots. Soak seed pieces in compost tea before planting to help suppress diseases. Plant in well-drained, warmed soil and cover lightly to encourage rapid sprouting. Cold, wet soil encourages rot.

Leaves discolored and puckered or curled. Causes: Leafhoppers; aphids; viral diseases; bacterial ring rot. If leaves have yellow patches and brown edges, look for leafhoppers—tiny green or brown insects that suck plant sap and hop, scuttle sideways, or fly when disturbed. Spray with insecticidal soap or pyrethrin to control. Prevent infestations by covering plants with row cover when they come up.

If leaves are stippled yellow and stunted, look for aphids. Potato aphids are tiny pink


POTATO ◆ What Goes Wrong and Why
Potatoes riddled with tunnels. Cause: Wireworms. Wireworms are yellowish brown, hard, segmented larvae.
1¼" Larva
½"
Adult
Leaves with water-soaked brown spots. Cause: Late blight. Potatoes have dark, purplish blotches on skin; dark, corky areas in flesh.
Potatoes with gray to black areas in flesh; centers may be hollow. Cause: Waterlogged soil; temperature extremes. Rot organisms may invade cavities.

insects and are often found on young leaves. For mild infestations, knock pests off plants with a blast of water. Spray plants with insecticidal soap in the evening to control. Prevent infestations by covering plants with row cover when they come up.

If leaf edges roll upward and are yellow-green, the plants may have leafroll virus. Destroy infected plants. Prevent problems by controlling aphids, which spread the disease as they feed, or by planting resistant cultivars such as 'Katahdin' and 'Yukon Gold'. If leaves are dark green or mottled with yellow, the plants have one of many viral diseases. Destroy infected plants. Prevent problems by controlling aphids that spread viruses.

If leaves turn yellow between the veins and curl upward, the plant is probably suffering from bacterial ring rot. Shoots are stunted at the tip and may wilt. Wilted stems cut near the soil exude a whitish ooze. Destroy infected plants. Prevent problems by planting certified disease-free seed and by washing knife after each tuber while cutting seed pieces.

Leaves yellow; plant stunted and may be wilted. Causes: White grubs; tuberworms; wireworms; black leg; root knot nematodes; Verticillium wilt. If plants wilt suddenly, look for fat white grubs with brown heads, pinkish white larvae, or yellow to reddish brown, hard, segmented larvae chewing on roots or tubers. See "Potatoes riddled with tunnels" on page 191 for descriptions and controls.

If the stem is black and shrunken for a few inches above the soil line, the plant has black leg, a bacterial disease. Destroy diseased plants. To avoid black leg, plant potatoes in well-drained soil, and don't overwater. Cultivars

such as 'Atlantic', 'Katahdin', 'Kennebec', and 'Red Pontiac' are resistant.

Stunted roots with swollen galls and tubers with warty skin are symptoms of root knot nematode infestation. Tubers are edible if peeled. Destroy infested plants; do not compost them. To control these pests, apply chitin or parasitic nematodes to the soil.

If roots and stem are undamaged, the plants may have Verticillium wilt. Stems cut near the soil line are discolored inside. This fungal disease usually appears when the plants flower. Destroy infected plants. Prevent problems by planting tolerant cultivars such as 'Beltsville' and 'Rhinered'.

Leaves with gray-brown, concentrically ringed spots. Cause: Early blight. Spots may merge and cover entire leaf, which then yellows and falls off. This fungal disease is active during warm, rainy weather. Spray plants with copper or bordeaux mix if symptoms are present and weather is warm and wet. Prevent problems by spraying plants with an antitranspirant before symptoms appear if you have had problems in the past, or by planting resistant cultivars such as 'Butte', 'Kennebec', and 'Krantz'.

Leaves with water-soaked brown spots. Cause: Late blight. Spots expand rapidly and develop a light halo. A white, velvety growth appears on the undersides of spots in wet weather. Stems are also infected and become dark and water-soaked. This fungal disease is active during moderately warm, rainy weather. Spray plants with copper if symptoms are present and weather remains wet to stop further symptom development. Prevent disease problems by spraying plants with compost extract when they come up and every 2 weeks throughout the season or by planting tolerant cultivars such as 'Butte', 'Cherokee', 'Katahdin', 'Kennebec', 'Krantz', 'Onoway', 'Rosa', and 'Sebago'.

Leaves with small holes. Cause: Flea beetles. Treat plants with pyrethrin spray or dust to control flea beetles if damage is severe. These tiny black, brown, or bronze insects hop when disturbed. Prevent problems by covering newly planted potatoes with row cover until they get large and able to tolerate insect damage. Apply parasitic nematodes to the soil to help control overwintering flea beetle larvae in the soil.

Leaves with large, ragged holes or leaves missing. Causes: Colorado potato beetles; blister beetles. Colorado potato beetles are oval, yellowish orange, hard-shelled, ⅓″ long beetles with black stripes. Larvae are soft-bodied, humpbacked, dark orange grubs with 2 rows of black spots down each side of their bodies. Eggs are orange and laid in rows on undersides of leaves. Overwintering adults appear on young plants in spring; handpick beetles zealously to reduce subsequent generations. Squash any eggs you see as well. Spray plants with BTSD as soon as you see any larvae. Prevent problems by covering plants with row cover before beetles appear. A thick mulch of loose straw around the plants may help prevent Colorado potato beetle damage.

Blister beetles are ¾″ long, elongated and thin, metallic, black, blue, purple, or brown insects. Wear gloves to handpick, since these beetles secrete a substance that may cause blisters. Spray plants with pyrethrin if damage is severe. Blister beetle larvae help control grasshoppers, so think twice before spraying to control them if grasshoppers are a problem in your area.

Tuber Problems

Potatoes small. Causes: Poor growing conditions; calcium deficiency. See "Culture" on page 188 for growing guidelines. If soil test indicates calcium deficiency, amend soil as needed.

Potatoes with green patches on skin. Cause: Exposure to light. Tubers exposed to light often turn green and develop a toxic substance known as solanine. Peel off green

tissue before eating. Prevent greening by hilling plants with soil or mulch and renewing it as necessary. Store potatoes in the dark.

Potatoes with brown or black spots or patches on skin. Cause: Scurf. Peel off spots before using tubers. Soak seed pieces in compost tea before planting to help suppress fungal diseases. Do not plant spotted tubers: The resulting plants will produce only small tubers, many of which will rot.

Potatoes with rough, corky spots on skin. Cause: Scab. Trim out spots before using tubers. Prevent this fungal disease by keeping soil pH below 5.5 and planting resistant cultivars such as 'Beltsville', 'Norland', 'Onoway', 'Pungo', 'Rhinered', 'Russet Burbank', 'Russian Banana', and 'Superior'.

Potatoes with wartlike bumps. Cause: Root knot nematodes. See "Leaves yellow; plant stunted and may be wilted" on page 189 for controls.

Potatoes knobby. Cause: Uneven soil moisture. If tuber growth is interrupted because of lack of soil moisture, tubers are often deformed. Keep soil moist, but not soggy, and never let it dry out.

Potatoes with a black, rotted ring at stem ends. Cause: Bacterial ring rot. Tubers have a soft, light brown ring in the flesh near the skin. See "Leaves discolored and puckered or curled" on page 188 for controls.

Potatoes with dark blotches on skin; flesh with dark, corky areas. Causes: Early blight; late blight. Trim out corky areas before using; discard severely affected tubers. See "Leaves with gray-brown, concentrically ringed spots" and "Leaves with water-soaked brown spots" above for controls.

Potatoes with gray to black areas in flesh; centers may be hollow. Causes: Waterlogged soil; extreme temperatures; potassium or phosphorus deficiency; mechanical injury; viral disease. Potatoes grown in wet, poorly drained soil often grow too fast and may develop a discolored and/or hollow area in the center. Prevent problems by keeping soil moist, but not soggy.

Extremely hot weather or cold snaps before potatoes are harvested can cause similar symptoms. Prevent problems by keeping tubers well-covered with hilled-up soil or mulch.

Phosphorus or potassium deficiency can cause spots or patches of dark flesh. Oversize tubers with hollow centers may also indicate potassium deficiency. If deficiencies are suspected, have soil tested and amend as needed. If plants show symptoms of phosphorus deficiency, raise soil pH to 6.0 so the mineral will be more available to the plants.

Rough handling can cause mechanical injury, such as bruising, that appears as discolored areas on the flesh. Handle tubers gently when harvesting and storing to prevent problems. Plants suffering from viral diseases may produce deformed or discolored tubers. See "Leaves discolored and puckered or curled" on page 188 for controls.

Potatoes riddled with tunnels. Causes: Tuberworms; wireworms. If tubers have browned, silk-lined tunnels, look for tuberworms. These pinkish white larvae are ½" long and feed in tubers, stems, and leaves. Destroy infested tubers and plants. Prevent problems by keeping tubers hilled with soil as they grow and by removing the dead vines before digging tubers. Cover plants with row cover to prevent adult moths from laying eggs.

Wireworms are yellow to reddish brown, hard, segmented larvae up to 1½" long that tunnel into tubers and chew on roots. Adults are dark-colored, elongated click beetles. Apply parasitic nematodes to the soil before planting to control them. Avoid planting potatoes where sod or grain grew the previous season, because wireworms are often numerous there.

Potatoes spoil in storage. Cause: Bacterial or fungal rots. Poor growing conditions or improper curing or storage may encourage various rot diseases. See "Culture" on page 188 for growing guidelines.

Let vines yellow and dry before carefully digging tubers. Sort out any bruised, cut, cold injured, or diseased potatoes and keep them cool (around 40°F) until they can be used. Cure healthy tubers by storing them between 50° and 60°F for 2-3 weeks, then store them between 35° and 45°F in a humid place.

Primula

Primrose. Perennials.

This large genus includes more than 400 species of mostly low-growing plants noted for numerous brightly colored and often fragrant blossoms. The many species, hybrids, and cultivars range from 5″ to over 2′ tall. Spring flowers bloom in a wide range of colors. Primrose foliage is coarse and crinkled; large, bright green leaves form a rosette below the flowers.

Primroses are hardy (some to Zone 3), but prefer humid regions without extreme heat or cold. Moisture is critical for primroses; few tolerate any drought. Plant in partial shade in well-drained, rich, organic soil. Healthy primroses have few pest problems. Low leaves and moist soil attract slugs; see "Leaves with large, ragged holes" on page 177 for controls.

Pyracantha

Firethorn. Shrubs.

Firethorns are thorny, evergreen plants grown for their handsome glossy foliage and the persistent red, orange, or yellow fruit. Firethorns adapt well to foundation plantings; upright cultivars are excellent for hedges.

Set out in spring as balled-and-burlapped or container-grown plants in full sun or light shade. Avoid alkaline soils and locations subject to strong winter winds. When possible, choose disease-resistant cultivars like 'Apache', 'Mohave', or 'Teton'.

Problems

Leaves, flowers, and branches blackened. Cause: Fire blight. This bacterial disease causes new shoots to wilt suddenly, turn dark, and die back. The disease eventually spreads, killing the whole plant. Lush new growth is particularly susceptible, so avoid overfertilizing. Prune out diseased tissue, cutting back at least 6″ beyond the discolored area; destroy or dispose of prunings. Disinfect pruners after each cut in a 10 percent bleach solution (1 part bleach to 9 parts water). Spray bordeaux mix the following spring during flowering.

Leaves and berries with black, scabby areas. Cause: Scab. Infected leaves eventually turn yellow and brown before falling off the plant. Damaged fruit is unsightly. Clean up fallen leaves and berries. The following year, spray plants twice, 2 weeks apart, with bordeaux mix.

Leaves skeletonized; branches webbed. Cause: Webworms. These 1″, pale green to nearly black caterpillars have a dark or light stripe down the back and 3 dark spots on the side of each segment. They feed on leaves and spin silken webs around leaves and stems. Young plants may die; older ones can be seriously weakened. Break up and remove the webs; spray leaves with BTK.

Leaves wrinkled and discolored. Cause: Aphids. See "Leaves wrinkled and discolored" on page 235 for controls.

Leaves pale and mottled. Cause: Lace bugs. These 1/10″, dark-colored bugs have lacy-patterned wings. They feed on the undersides of leaves and deposit small black spots of

excrement. Severe infestations can cause early leaf drop. Control by spraying leaves (especially the undersides) with superior oil or insecticidal soap.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. See "Leaves yellow; stems and leaves covered with small bumps" on page 237 for more information.

Leaves stippled with yellow; foliage webbed. Cause: Spider mites. See "Leaves stippled with yellow; foliage webbed" on page 236 for controls.

Q·R

Quercus

Oak. Trees.

Oaks typically have large, lobed leaves and rough bark; they are mostly slow-growing and long-lived, valued both for their ornamental effect and for their wood. Those suitable for northern planting are deciduous; there are a number of evergreen oaks grown in the South. The larger species are primarily used as ornamentals on large properties; some of the shorter-growing ones are valued as street trees and for smaller gardens.

Set out in spring as balled-and-burlapped plants. Full sun and deep, fertile, well-drained, somewhat acid soils suit them best. Oaks vary in their moisture requirements; ask your local nursery owner or extension agent about the needs of the oak trees you have.

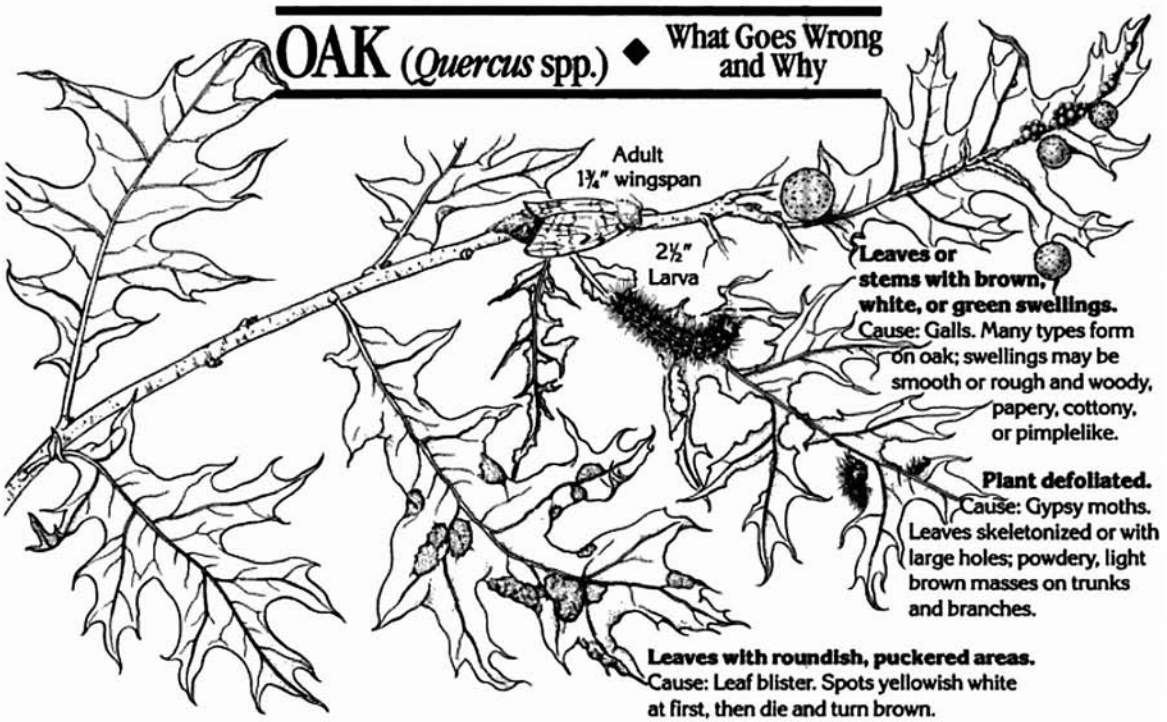
Problems

Plant defoliated. Cause: Gypsy moths. The larvae of the gypsy moth are particularly fond of oaks and can easily defoliate a tree. See page 194 for an illustration of the pest and the damage it causes. For control measures, see "Plant defoliated" on page 236.

Leaves skeletonized or with large holes; branches may be webbed. Cause: Caterpillars. Many caterpillars feed on oak foliage. See "Leaves skeletonized or with large holes; branches may be webbed" on page 236.

Leaves or stems with brown, white, or green swellings. Cause: Galls. A number of tiny mites and insects feed on oaks, causing swellings on leaves and twigs. For an illustration of common oak galls, see page 194. Damage is rarely serious. Prune off and destroy affected leaves and twigs.

Leaves with roundish, puckered areas. Cause: Leaf blister. This fungal disease causes yellowish white blisters, up to ½" in diameter,


OAK (Quercus spp.) ◆ What Goes Wrong and Why
Adult
1¼" wingspan
2½"
Larva
Leaves or stems with brown, white, or green swellings. Cause: Galls. Many types form on oak; swellings may be smooth or rough and woody, papery, cottony, or pimplelike.
Plant defoliated. Cause: Gypsy moths. Leaves skeletonized or with large holes; powdery, light brown masses on trunks and branches.
Leaves with roundish, puckered areas. Cause: Leaf blister. Spots yellowish white at first, then die and turn brown.

on oak foliage. For an illustration of leaf blister, see above. Although symptoms may appear serious, little actual harm is done to the tree, so control isn't necessary. To prevent damage the following year, spray branches with lime-sulfur or bordeaux mix before the buds open in spring.

Leaves with powdery white coating. Cause: Powdery mildew. See "Leaves with powdery white coating" on page 237 for controls.

Leaves and shoots blackened; leaves with moist or brown sunken spots. Cause: Anthracnose. For controls, see "Leaves and shoots blackened; leaves with moist or brown sunken spots" on page 238.

Leaves yellow; stems and leaves covered with small bumps. Cause: Scales. See "Leaves yellow; stems and leaves covered with small bumps" on page 237.

Trunk or branches with oozing lesions; branch tips die back. Cause: Canker. For more information, see "Trunk or branches with oozing lesions; branch tips die back" on page 238.

Leaf edges browned; leaves wilt and drop early. Cause: Oak wilt. Symptoms of this fungal disease usually show up first on the top of the tree, eventually spreading to the lower branches. Infected trees die quickly, often within 1 year of infection. There is no cure; remove and destroy infected trees.

Leaves stippled with white. Cause: Oak lace bugs. Adult lace bugs are 1/10", flattened, dark insects with lacy-patterned, silvery white wings. Both the adults and the tiny nymphs feed on the undersides of leaves, sucking the sap and producing a gray, splotched or stippled appearance to the upper sides of the foliage. Leaves may curl, turn brown, and drop

early. At the first sign of damage, spray with insecticidal soap, paying particular attention to the undersides of the leaves. Repeat the application if pests reappear in mid- to late summer. For severe infestations, spray with superior oil, or pyrethrin as a last resort.

Leaves rolled and chewed. Cause: Leafrollers. These ½", green caterpillars form small webs on shoot tips and feed on leaves and buds inside. Break open webs and handpick larvae; spray BTK at first sign of damage.

Leaves with spots. Cause: Leaf spots. For controls, see "Leaves with spots" on page 237.

Leaves tunneled. Cause: Leafminers. See "Leaves tunneled" on page 237 for controls.

Leaves stippled with yellow; foliage webbed. Cause: Spider mites. For controls, see "Leaves stippled with yellow; foliage webbed" on page 236.

Radish

Raphanus sativus (Cruciferae)

Radishes are annual and biennial vegetables grown for their crisp, peppery roots. Certain cultivars do not have fleshy roots, but are grown for their crunchy seed pods. Some Daikon radishes grow 2′ roots.

Most radishes do best in cool, moist conditions. They need a pH between 5.5 and 6.8 and light, relatively rich soil. Plant radishes as soon as soil can be worked in spring. Make small plantings weekly until early summer for a continuous supply of radishes. Temperatures between 50° and 65°F produce the best radishes; growth above 75°F is poor. Some cultivars of Daikon radishes are designed for summer planting and will flower without forming large roots if planted too early.

The secret to mild, tender radishes is rapid growth. Water heavily the first 2 weeks after they come up if soil is dry. A light application of compost is usually enough for a good radish crop. Radishes will not tolerate soils high in salt.

Radishes are related to cabbage and suffer from many of the same problems. Since leaves are not harvested, more insect damage can be tolerated than in cabbage plants. See the Cabbage entry beginning on page 52 for descriptions and controls. Prevent problems with Fusarium yellows by planting resistant cultivars such as 'Fancy Red', 'Fuego', 'Red Devil B', 'Red King', and 'Red Pak'.

Root Problems

Roots enlarged and clublike. Cause: Club root. Destroy plants suffering from this fungal disease. Prevent problem by rotating crops and providing good drainage. 'Red King' and 'Saxafire' are tolerant cultivars.

Roots riddled with slimy, winding tunnels. Cause: Cabbage maggots. Maggots are white and ¼" long. Adults look somewhat like houseflies and lay eggs on the soil near the base of the plants. Frequent, light cultivation when plants are young helps to decrease maggot populations. Remove and destroy infested plants.

Roots small and imperfect. Causes: Nitrogen deficiency; phosphorus deficiency; lack of water; excessive heat; wrong season for cultivar. Yellow or pale leaves suggest nitrogen deficiency. Purple leaves suggest phosphorus deficiency. Spray leaves with compost tea or fish emulsion, or side-dress with compost to correct either deficiency. If soil was dry, water subsequent plantings well. Do not try to grow most radishes in the hottest summer months, wait till cooler fall weather. Planting radishes in the shade of other plants may extend the spring season somewhat. Check